The prediction of Human-sociability in the domestic cat *Felis silverstris catus*

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Abstract:

Temperament consists of stability in behavioural tendency across both contexts and time. Variability in temperament may affect how suited cats are to reside in certain types of environment. Over the past three decades many studies have been performed on the domestic cat in order to assess their temperament, often with a focus on social aspects of their behaviour, particularly how amenable they are towards humans. Whilst such tests could be used to evaluate or infer an individual's suitability for domestic living, research in this area frequently lacks sufficient demonstration of reliability and validity. In addition, little consideration is often given to the practicality of the measures and tests proposed. Thus the ability to accurately measure key traits of relevance to human-sociability in a practical way remains largely unknown, as does the predictive validity of such tests in relation to future behavioural tendencies in other contexts.

The aims of this PhD were to address these issues by developing robust measures with demonstrable reliability, validity and practicality, which could be used to evaluate the sociability of cats towards humans, and in a predictive capacity in relation to post-rehoming behaviour. A neurobiological framework based on relevant affective systems (a balance between FEAR, SEEKING and RAGE *sensu* Panksepp) was used to define 'Human-sociability' and the 'aggressive response'. The deconstruction of these traits allowed the operational definition of psychobiologically based behavioural tendencies, which were hypothesised to be useful predictors of sociability towards humans. Four standardised behavioural tests and 65 basic behavioural measures were then used to provide information on these traits. These measures were subsequently refined based on their reliability, validity and practicality. Many measures were discarded because they were found to be influenced by (short-term) temporal and/or social factors (i.e. familiarity of a person or their interaction style), or were less practical to perform (without appearing to explain much additional variation within the data). At this point only nine individual measures were retained, from only one of the four initial behavioural tests. However, further analysis indicated that the majority of these remaining measures were either influenced by longer-term temporal factors or by the environment (i.e. individual rehoming centre). These findings suggest many behavioural measures currently used in the assessment of temperament may be invalid.

In light of these results, other methods of trait assessment were explored. A series of questionnaire items were developed and put through a similar process to determine their reliability, validity and

practicality, based on the same neurobiological framework as the previous behavioural experiments. From an initial twenty-eight items, ten demonstrated sufficient practicality, inter and intra-rater reliability and temporal stability within the rehoming centre and were thus retained within a final model that could be used to generate behavioural ‘profile scores’ for cats within the rehoming environment. This refined questionnaire model demonstrated good content and face validity, containing three clusters of measures that were hypothesised to represent social aspects of all core processes of interest (FEAR, SEEKING and RAGE). In addition, good construct validity of measures was also demonstrated via the convergence of individual items hypothesised to share similar emotional underpinnings and via the discrimination between those that were not. A subset of measures from this model were found to have good predictive validity in relation to future post-rehoming behaviour, and were also associated with owner post-adoption ‘satisfaction’ scores. However, this subset of items no longer included RAGE reactivity and thus the criterion validity of the questionnaire in relation to the behavioural manifestation of this core process post-adoption is limited. Based on these findings, an initial framework process for the behavioural assessment, management and matching of cats to suitable owners for use within the rehoming environment has been proposed (the Lincoln Rehoming centre Cat Assessment Tool (L-RCAT)).

This research has resulted in the provision of a first-of-its-kind tool that can be used to generate practical, non-invasive and valid information about the behavioural tendencies of cats in relation to aspects of human-sociability, not only in-situ (i.e. within the rehoming environment), but also in a predictive capacity in relation to future ex-situ behaviour (i.e. post adoption within the home), as well as to aspects of owner-satisfaction and thus the potential ‘rehoming success’ of individuals.

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Glossary:

Definitions of key terms relevant to the research:

Affective processes:

Genetically dictated 'complex intrinsic functions of the brain', triggered in response to homeostatic drives or external environmental stimuli, which influence the internal or subjective experience of an individual (Panksepp 2005). Emotional affective processes, (those triggered typically in response to external environmental stimuli (Panksepp 2005)) operate or exist at three levels; emotional reaction, mood and temperament (See Gray and Watson 2001).

Behaviour trait:

A descriptive reference to a specific feature of personality or temperament within an individual (For examples see Hausberger et al, 2004, Biro and Stamps 2008, see also Mills and Marchant-Forde 2010).

Behavioural tendency:

A predisposition towards a certain type of behavioural response within a given situation (see Sih *et al* 2004, Biro and Stamps 2008, Wolf and Weissing 2012 for examples of its use).

Personality:

Underlying behavioural tendencies that;

(i) Affect the behaviour expressed by individuals in different contexts in a meaningful way (e.g. Dall *et al* 2004, Dingemanse and Wolf 2010).

(ii) Are primarily influenced by the interaction between genetics and life experiences, particularly during key developmental stages (e.g. Carere *et al* 2005, van Oers *et al* 2009, Rödel and Meyer 2011).

(iii) Have elements of context generality and temporal consistency in the way they influence the behaviour of an individual (e.g. Dingemanse *et al* 2002, Réale *et al* 2007; Sih and Bell 2008, Stamps and Groothuis 2010, but may also respond dynamically during an individuals' life history (See Frost *el al* 2007, Dingemanse *et al* 2010).

(iv) Within given populations and contexts, lead to greater behavioural diversity inter-individually than intra-individually (see Stamps and Groothius 2010).

Temperament:

The manifestation of underlying *behavioural tendency* across given contexts (both temporal and situational), relating to particular subsets of behaviours which are influenced by affective processes (see Rothbart and Bates 1998, Box 1999, Rothbart 2007, Réale *et al* 2007). Evidence would suggest various temperament traits are heritable and linked to relevant fitness outcomes (e.g. Réale *et al* 2007)

List of abbreviations and other terms used throughout the thesis:

BDCH – Battersea Dogs And Cats Home

WG – Wood Green, The Animals' Charity

MHW – The Mayhew Animal Home

CP – Cats Protection

FA – Factor Analysis

LDA – Linear Discriminant Analysis

HCA – Hierarchical Cluster Analysis

'Behavioural measures' Dendrogram – Dendrograms produced from HCAs based on the relationship between individual measures. Dendrograms were used to identify separate groups or 'Clusters' of individual measures.

'Cat identity' Dendrogram – Dendrograms produced from HCAs based on the relationship between the individual cats.

List of specific test terms and measures used throughout thesis:

Chapter 2:

Behaviour Tests:

Test 1: 'Food withholding'. A person stands in the cats unit with a bowl of food during morning feeding time. During the test, access to the food is briefly denied to the cat.

Test 2: 'Human interaction & Play test'. A person sits in a cat's pen and during different stages of the test either ignores the cat, strokes the cat or plays with the cat

Test 3: 'Emergence test'. A cat is put into a cat carrier which is then placed in an unfamiliar room with either a familiar or unfamiliar person inside. The person either ignores the cat (passive condition), or encourages interaction (active condition).

Test 4: 'Less food than 'expected' (quantity and quality reduced)'. A person stands in a cat's pen and 'shows' the cat a bowl of wet food before placing a different bowl containing a few pieces of kibble on the floor instead. After a delay the bowls are switched and the cat is given the wet food. This is then briefly taken away and then put back again.

Behavioural measures:

An initial collection of 65 individual behavioural measures that were taken across the four different tests. Each measure was designed to measure aspects of the core emotional process of interest (SEEKING, FEAR and RAGE) in either social or physical contexts.

Social conditions within behaviour tests:

- Unfamiliar person: A person the cat had never met prior to the test period
- Familiar person: A member of staff that had socialised with and been the primary carer for the cat at least seven days prior to the start of the test period
- Active condition (Emergence test only): The test person encourages interaction with the cat in a controlled standardised way
- Passive condition (Emergence test only): The test person ignores the cat and does not interact with it

Behavioural test models:

A series of models containing individual measures from the behaviour tests. During the process of test refinement, subsequent models containing fewer measures were identified (i.e. from the original Model#1 to the final Model#6).

- Model #1: A model containing a total of 37 individual behavioural measures, from across the four different behaviour tests. Measures were divided in to three main clusters based on the groupings evident from the HCA dendrogram outputs.
- Model #2: A model containing a total of 31 individual behavioural measures, from across three of the different behaviour tests (Tests 1-3). Measures were divided in to four main clusters and identified as representing the following emotional process and contexts:
    - Behaviour cluster 1: RAGE - (Social context)
    - Behaviour cluster 2: SEEKING - (physical context)
    - Behaviour cluster 3: SEEKING - (social context) *and (RAGE):- (social context)*
    - Behaviour cluster 4: SEEKING - (physical context*) and (RAGE): - (physical context)*
- Model #3: A model containing a total of 12 individual behavioural measures taken from clusters 1-4 (see above) and from Test three only.
- Model #4: A model containing a total of 9 individual behavioural measures, taken from clusters 1-3 (see above) and from Test three only.

- Model #5: A model containing a total of 4 individual behavioural measures, taken from clusters 1-2 (see above) and from Test three only.

Chapter 3:

Behavioural test models:

- Model #6: A model containing a total of 5 individual behavioural measures, taken from clusters 1-3 (see above) and from Test three only. Model based on the measures contained in Model#4, minus the four individual measures that were longitudinally unreliable. Measures were divided in to two main clusters identified as:
    - Behaviour Cluster 1 - sRB: RAGE (Social context)
    - Behaviour Cluster 3 - s/pSB: SEEKING (Social OR Physical context)

Chapter 4:

Questionnaire 'QA.1'

A behavioural questionnaire that was developed using the same underpinning theoretical framework and operational definitions that was used for the behavioural tests and measures. The questionnaire contained 28 individual items, describing aspects of the behaviour of the cat, each linked to one or more of the specific core emotional processes of interest (FEAR, SEEKING, RAGE) and aimed to represent these across both social and non-social contexts. Items were ranked along a five point scale ranging from 'strongly disagree' to 'strongly agree' or 'never' to 'always'. Items were based around what were anticipated to be relatively common every-day situations during human-cat interactions and husbandry routines, where a greater frequency or intensity of a specific behavioural response was anticipated to relate to high reactivity of the FEAR, SEEKING or RAGE systems (or in some instances their combinations), and thus a greater expression of the associated traits of interest. The questionnaire was designed to be filled in by rehoming centre staff after working with a specific cat for a minimum of seven days.

‘L-CAT’

A subset of ten measures taken from Questionnaire QA.1 that were found to demonstrate sufficient inter and intra-rater reliability as well as longitudinal stability within the rehoming environment.

Chapter 5:

L-CAT cluster scores:

Cats were given three composite scores that were calculated based on the grouping of the ten individual items as identified from HCA outputs. These cluster scores were then used to create potential behavioural profiles. The three clusters were:

- sSQ: SEEKING (social context)
- sRQ: RAGE (social context)
- sFQ :FEAR (social context)

Behaviour Test clusters scores:

Cats were given two composite scores that were calculated based on the grouping of the five individual behavioural measure items from model #6 that were longitudinally reliable

- Cluster 1 – sRB: RAGE (Social context)
- Cluster 3 - s/pSB): SEEKING (Social OR Physical context)

Chapter 6:

QA.3(‘Cat adopter’) questionnaire:

A modified version of QA.1 that was sent out to owners (either by post or link to a questionnaire site via email) that had recently adopted a study cat from one of the four rehoming centres used in the study. This questionnaire was designed to gather owner ratings of their cat’s behaviour on the same

28 items as in QA.1. Additional questions were also added in order to gauge post-adoption ‘owner satisfaction’.

Cat <u>*owner*</u> *survey:*

A completely online survey based on questionnaire QA.3.The survey was designed to be filled in by pre-existing cat owners (a stable cat-owning population) that did not rehome study cats. Owners were asked to answer the questionnaire about one cat from their household and were contacted six months after completing an initial QA.3 to repeat the process.

(refined) L-CAT:

A refined version of the *L-CAT*, containing the six individual items that were reliable between the rehoming centre and the home.

(refined)L-CAT cluster scores:

Cats were given two composite scores that were calculated based on the grouping of the six individual (refined) L-CAT questionnaire items as identified from HCA outputs. The two clusters were:

- sSQ(r): SEEKING (social context)
- sFQ(r) :FEAR (social context)

Chapter 7:

Questionnaire ‘QA.2’

A modified version of QA.1 that was handed out to all prospective cat adopters that visited the rehoming centres involved in the study prior to seeing and selecting their cat. The questionnaire was designed to gauge the owner’s *ideal* preference in relation to the 28 items contained in QA.1.

Chapter 8:

L-RCAT:

The 'Lincoln Rehoming centre Cat Assessment Tool'. An initial framework process for the behavioural assessment, management and matching of cats to suitable owners for use within the rehoming environment. The L-RCAT framework uses information generated from the L-CAT, the L-CAT(c) and the L-CAT(o)

L-CAT(c)

A modified version of the (refined) L-CAT, containing five of the six questionnaire items from the L-CAT (those that were reliable between the rehoming centre and the home and also associated with owner post-adoption satisfaction). It is suggested the L-CAT(c) be used for the purposes of matching of cats with suitable owners as well as educating owners about the predicted post-adoption behaviour of the cat.

L-CAT(c) cluster scores

Two composite scores calculated via the (HCA based) clusters of the five individual items in the L-CAT(c). The two clusters represented are:

- sSQ(c) : SEEKING (social context)
- sFQ(c) :FEAR (social context)

L-CAT(o)

A modified version of the L-CAT (c), designed to gauge prospective owners' ideas in relation to the five behavioural items, used for the purposes of matching owners with suitable cats.

L-CAT(o) cluster scores

Two composite scores based on L-CAT(o) items, based on the grouping of items in the L-CAT(c) clusters. The two clusters represented are:

- L-CAT (o) cluster - sSQ(o) : SEEKING (social context)
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Figure 7.4 Scatter plot of Z scores for each item comparing QA.2 'ideal' ratings between 'completely satisfied' and 'not completely satisfied' owner ratings, created using Mann-Whitney-Wilcoxon Tests. Z scores plotted by value (from positive to negative). Dotted lines indicate groups of items with different levels of relative statistical significance. Items represented in abbreviated form. See Appendix 7.2 for full item content.

Chapter 8: Discussion.

Tables:

Table 8.1 List of initial refined behavioural measures retained in Chapter 2, their representation across each cluster, relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster

1 contained behavioural measures that represented social RAGE, Cluster 2 measures of physical SEEKING and Cluster 3 social SEEKING.

Table 8.2 List of longitudinally reliable measures identified in Chapter 3, their representation across each cluster, relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster sRB contained behavioural measures that represent social RAGE, whilst cluster s/pSB social and/or physical SEEKING.

Table 8.3 The ten L-CAT items reliable within the rehoming environment and their place within each cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. Cluster sSQ contains questionnaire items that represent social SEEKING, cluster sRQ social RAGE, and cluster sFQ social FEAR.

Table 8.4 The six (refined) L-CAT items reliable between the rehoming environment and the home and their place within each cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. Cluster sSQ contains questionnaire items that are hypothesised to represent social SEEKING and cluster sFQ social FEAR.

Table 8.5 Descriptive statistics for individual L-CAT scores for each cluster (sSQ - social SEEKING, sRQ – social RAGE and sFQ – social FEAR). Clusters comprised of 10 questionnaire items rated by rehoming staff members in relation to the cats' behaviour, that were reliable within the rehoming centre environment (see Table 8.3). Maximum, minimum, mean and median scores along with the Standard Deviation and Inter-Quartile Ranges are displayed.

Table 8.6 Descriptive statistics for individual L-CAT(c) scores for each cluster (sSQ - social SEEKING, and sFQ – social FEAR). Clusters comprised of 5 questionnaire items rated by rehoming staff members in relation to the cats' behaviour that were reliable between the rehoming centre environment and the home and were also associated with higher post-adoption satisfaction. Maximum, minimum, mean and median scores along with the Standard Deviation and Inter-Quartile Ranges are displayed.

Table 8.7 Descriptive statistics for individual 'owner ideal' L-CAT scores for each cluster (sSQ - social SEEKING, and sFQ – social FEAR). Clusters comprised of 5 questionnaire items rated by prospective adopters based on their 'ideals' (clusters correspond to those in Table 8.6). Maximum, minimum, mean and median scores along with the standard deviation and inter-quartile ranges are displayed

Table 8.8 The L-CAT scoring sheet containing items reliable within the rehoming environment, used to create the identified behavioural profiles in relation to social SEEKING (sSQ), social RAGE (sRQ) and social FEAR (sFQ) cluster scores (see Profiles (i-v) in section 8.5.1). Scores are generated based on the Lincoln Cat Assessment Test (L-CAT) questionnaire (Figure 8.9). Items on the questionnaire are scored from (1 to 5) left to right hand side from the L-CAT. Items with an (R) next to them are then reversed prior to cluster score calculation. Boxes are provided to impute the total cluster scores in to, along with indication of whether this score is of a relatively ‘high’, ‘medium’ or low value.

Table 8.9 Provisional cat profiles and their suggested management. Table of suggested *in-situ* environmental and behavioural management outcomes for each of the provisional profiles identified in section 8.5.1 (Profiles (i-vi)), based on a combination of high and/or low L-CAT cluster scores (sSQ, sRQ and sFQ). In addition, intervention priority, ‘owner matching’ and potential suitable future physical and social environments for each profile are outlined

Table 8.10 L-CAT (c) scoring system: Five of the six (refined) L-CAT items (those that were reliable from the rehoming centre to the home and were also associated with increased owner satisfaction) taken from the L-CAT Questionnaire, Figure 8.2) are used to create composite item scores for the purposes of cat-owner matching. Answers for each item on the L-CAT questionnaire (staff assessments of the cat) are scored from the left to right-hand side of the page (1= far left, 5-far right). sSQ(c) and sFQ(c) cluster scores are then calculated by adding items together (q5+q9 for sSQ(c) and q1+q2+q4 for sFQ(c)). Items that need reversing prior to calculating cluster scores are indicated with an (R) beside them. Boxes are provided to input the total cluster scores, along with indication of whether this score is of a relatively ‘high’, ‘medium’ or ‘low’ value.

Table 8.11 L-CAT (o) scoring system: The (refined) L-CAT items, taken from the owner ‘ideal’ version of the L-CAT Questionnaire (the L-CAT (o) questionnaire, Figure 8.3) are used to create composite item scores for the purposes of cat-owner matching. Answers for each item on the L-CAT(o) questionnaire are scored from the left to right-hand side of the page (1= far left, 5-far right). sSQ(o) and sFQ(o) cluster scores are then calculated by adding items together (q5+q9 for sSQ(o) and q1+q2+q4 for sFQ(o)). Boxes are provided to impute the total cluster scores in to, along with indication of whether this score is of a relatively ‘high’, ‘medium’ or ‘low’ value.

Table 8.12 A provisional Cat-owner matching guide, suitable for matching Profile (i-iii) cats with prospective adopters. Owner assessed on relative sSQ(o) and sFQ(o) scores (i.e. whether high of low) in relation to which cats they may or may not be suitable to rehome (based on a cat's sSQ(c) and sFQ(c) scores)

Figures:

Figure 8.1 Flow chart to represent an overview of the assessment process using the Lincoln rehoming centre cat assessment tool (L-RCAT). Assessments are based on information from the L-CAT and the L-CAT subsets; L-CAT (c) (cat version) and L-CAT (o) (owner version) to identify different potential cat profiles (see section 8.5.1 for descriptions), the potential need for environmental and/or behavioural interventions within the rehoming environment (those of the highest intervention priority red, moderate priority yellow and lower priority green) and also relevant potential rehoming outcomes.

Figure 8.2 The Lincoln Cat Assessment Test (L-CAT). Questionnaire containing items found to be reliable *within* the rehoming environment. To be filled out by staff that have been working with (i.e. feeding/cleaning/socialising) a cat for at least 7 days prior to questionnaire completion. L-CAT items to be used to 'profile' cats primarily for *in-situ* management, and the L-CAT(c) items for the purposes of cat-owner matching (e.g. see Table 8.10).

Figure 8.3 L-CAT(o) Questionnaire: The owner version of the L-CAT(c) containing items found to be reliable *between* the rehoming environment and the home. Items are worded to ascertain prospective owners 'ideal' ratings for each behavioural item. To be filled out by prospective cat-adopters (prior to meeting or reserving specific cats) for the purpose of gauging owner 'ideals' that can then be matched with staff ratings of a cats' 'actual' behaviour to facilitate suitable cat-owner matching.

Ethical approval:

For all aspects of the project, ethical approval was given prior to data collection.
Internal approval was given by the University of Lincoln School of Science Ethics Committee.
External approval was given by each of the organisations/centres where research was conducted and included the following; Battersea Dogs and Cats Home, Cats Protection, The Mayhew Animal Home and Wood Green, The Animals Charity.

1 Chapter **1: Introduction**

1.1 Part 1: The assessment of individuality in *F. silvestris*

1.1.1 Individual differences in non-human animals:

Over the last several decades, the study of individual differences in the behaviour of non-human animals has received an increasing amount of attention across a range of species (both vertebrates (e.g. rhesus macaques, Capitanio 1999) and invertebrates (e.g. hermit crabs, Watanabe *et al* 2012)) as well as academic disciplines (from psychology, Gosling 1998, to evolutionary ecology, Dingemanse *et al* 2002, to animal cognition, Amy *et al* 2012). Such diversity in approaches is reflected in the range of different terminology and methodology used to study individual differences, as well as the causes and consequences of the behavioural differences that are being measured.

1.1.2 Individual differences and their implications:

Variations in the behavioural tendencies of individuals in response to similar stimuli have been studied in relation to various fitness consequences at both proximate (e.g. see Koolhaas *et al* 1999, David *et al* 2004), and ultimate (e.g. Wielebnowski 1999, Smith and Blumstein 2008) levels. These consequences may impact at the level of the individual (e.g. individual variation in exploratory behaviour, Dingemanse *et al* 2002 and in breeding status, Wielebnowski 1999) as well as at the level of the population (e.g. variability in behavioural styles across populations based on their ecological niches, Dingemanse *et al* 2007). Such inter-individual differences have most often been explored in ‘ex situ’ contexts, for example wild species studied in a captive environment; (e.g. Wielebnowski 1999, Dingemanse *et al* 2002, Martin 2005), or domestic species tested under laboratory or other novel or unfamiliar conditions (e.g. Murphy *et al* 1994, Anderson *et al* 2000, Cavigelli and McClintock 2003).

From a welfare perspective, individual variability has been assessed in both domestic species (e.g. Ruis *et al* 1999, Campbell *et al* 2003), and in wild individuals residing in zoo environments; (e.g. Sheperdsen *et al* 2004, Gold and Maple 2005, Weiss *et al* 2006). It is argued that such apparent individual differences may be of considerable importance, predicting the relative ability of an individual to 'cope' within a specific external setting (Broom 1988, Manteca and Deag 1993). From a human-animal interactions perspective, assessments of individuality in domestic species are often used to predict the future suitability of individuals to perform certain tasks (for example dogs tested for military or guide dog work; Sinn *et al* 2010, Serpell & Hsu 2001) or to live within a specific domestic environment (e.g. tests for aggression, fearfulness, human-sociability etc.; Ledger 1997, Netto and Planta1997, Hennessy *et al* 2001, van den Berg *et al*. 2003, Siegford *et al* 2003, Svartberg 2005). However, many of these types of studies have been criticised due to the frequent ‘ex situ’ nature of contexts within which individuals are tested, often combined with a general lack of appropriate metatheoretical and methodological foundation. As such, it is argued that there is the potential for apparent individual variation (or indeed a lack of it) to represent methodological artefact rather than meaningful or biologically relevant information (Uher 2011, also see Höjesjö *et al* 2002). It is thus important that where individual variation is to be measured, it is done using a suitable biological framework, and that the measures used are rigorously assessed in relation to their suitability and utility in explaining the underlying constructs of interest.

1.1.3 Individual differences in the domestic cat:

In the domestic cat, the manifestation and causes of individual differences, as well as their potential welfare implications have been studied, typically focusing on four contexts;

- Sociability towards humans; E.g. Lee *et al* 1983, Meier and Turner 1985, Turner 1985, Turner *et al* 1986, Feaver *et al* 1986, Mertens and Turner 1988, Reisner *et al* 1994, McCune 1992, 1995, Podberscek *et al* 1991, Bradshaw and Cook 1996, Gosling & Bonnenburg 1998, Lowe and Bradshaw 2000, Siegford *et al* 2003, Lee *et al* 2007, Iki *et al* 2011, Wedl *et al* 2001, Slater *et al* 2013a-c.

- Sociability towards conspecifics; E.g. Durr and Smith 1997, Van den Bos 1998, Barry and Crowell-Davis 1999, Bradshaw and Hall 1998.

- Neophobia/philia in relation to novel objects; E.g. McCune 1995, Marchei 2011, Durr and Smith 1997.

- Response to stressful environmental contexts; E.g. Caging and containment; McCune 1992, Hawkins 2005; Containment with forced proximity to conspecifics; Kessler and Turner 1997, Van den Bos 1998, and exposure to a water bath and other invasive procedures; Iki *et al* 2011.

1.1.3.1 Definitions and methodologies:

1.1.3.1.1 Individual differences:

Across all areas of research, both the methodologies used to assess individual differences, as well as terminologies used to describe what is being measured have varied significantly. For example, terms such as ‘responder style’ (McCune 1994), 'stress response' (Kessler and Turner 1997, Dybdall *et al* 2006 and Van den Bos 1998), and ‘coping strategy’ (Hawkins 2005) have all been used in situations where the responses of cats to stressful caging or other contained environments have been assessed. In each case, a variety of different measures have been used, including behavioural and postural scoring systems (Kessler and Turner 1997, Dybdall *et al* 2006), relative frequencies of behavioural patterns (Van den Bos 1998) as well as combinations of; behavioural time budgets and behavioural scoring systems (McCune 1994) and behavioural scoring systems and cortisol sampling (Hawkins 2005).

Between studies, the same or similar terms can often be used to refer to quite different types of behavioural measures in different contexts. For example terms such as 'coping strategy' have been used to describe the behavioural responses of kittens kept in a home environment when tested in an Open Field Test and with novel objects (Marchei 2009), as well as to explain individual variation in correlations between cortisol and behavioural scores taken from adult cats kept in cages (Hawkins 2005). Such discrepancies in both terminology and methodology are potentially problematic because they may ultimately hinder the ease of making cross-study comparisons as well as the ability to make general inferences in relation to a specific area of research.

1.1.3.1.1.1 Human-sociability:

With regards to studies attempting to assess ‘sociability’ towards humans, the methodologies are again considerably variable. These have ranged from the collection of multiple behavioural measures in standardised test scenarios (Podberscek *et al* 1991, Mertens and Turner 1988, McCune 1992, 1995, Slater *et al* 2013a,c) to observer (Turner *et al* 1986, Feaver *et al* 1986, Slater et al 2013b, Gartner *et al* 2014) and owner (Gosling & Bonnenburg 1998, Lee *et al* 2007) ratings based on impressions of individual cats over various unstructured encounters.

The various nomenclature used to describe the presence of apparent individual variation have included 'behavioural styles' (Feaver *et al* 1986, Lowe and Bradshaw 2000), 'personality' (Lee *et al* 2007), 'temperament' (Siegford, *et al* 2003, Iki *et al* (2011), 'behavioural patterns' (Bradshaw and Cook 1996), ‘behavioural variation’ (Turner *et al* 1986) and 'individual differences' (Durr and Smith 1997), with no clear or consistent definition of the terms used nor indication given as to why one term is preferred over another.

Even when using similar behavioural measures, the precision of the definitions given to apparent individual differences within their test populations has varied extensively. For example, several studies have measured the response of cats to both familiar and unfamiliar people using latency and frequency values (e.g. latency of cat to approach and rub a person, and frequency of rubs and vocalisations), but when attributing the variation present to some aspect of individual difference, some authors have used general terms such as ‘personality/ temperament’ (e.g. Podberscek *et al* 1991) and ‘individuality’ (e.g. Mertens and Turner 1988), whilst others have been much more specific and inferential in their interpretations, using terms more akin to specific *types* of individual differences, for example ‘friendliness’ and ‘boldness’ (Turner *et al* 1986, McCune 1992) and also ‘sociability’ (Wedl *et al* 2001). Furthermore, within the same study, terms which are arguably (not unrelated) but represent distinctly separate factors that govern the behavioural responses of cats towards humans, have been used interchangeably (e.g. Reisner *et al* 1994, Slater *et al* 2013b). For example ‘sociability’ (a trait which is influenced by both genetic and environmental factors (e.g. see Karsh 1984, Karsh and Turner 1988, Turner *et al* 1986, McCune 1995) is assumed to be synonymous with the level of ‘socialisation’ received (an experiential process which may impact upon sociability but independent of the internal qualities of the recipient (e.g. see Woolpy & Ginsburg, 1967, McCune 1995). This leads to confusion over what is actually being measured, and thus the specific purpose of the test.

Whilst such a variety of terminologies and methodological approaches in the assessment of individual variability exist, at a biological level, it is possible that many of these differences may be explained by referring to a common set of affective processes and associated neural mechanisms (Panksepp 1998). For example, the same emotional systems within the brain may influence both the exploratory behaviour of an individual during an Open Field Test (e.g. Siegford *et al* 2003, Marchei *et al* 2009) as well as the latency of an individual to approach a novel person (e.g. Mertens and Turner 1988, Podberscek *et al* 1991, McCune 1995). As such, it is possible that various different tests are in effect measuring aspects of the same underlying construct, even if it is expressed in a behaviourally varied way (e.g. see Mills *et al* 2006). A solid and precisely defined theoretical context is essential, however, in order to make sound scientific interpretations that can be generalised between contexts.

1.1.4 The importance of validity and reliability in the assessment of behavioural traits:

A behavioural 'trait' is essentially a representation of a specific aspect of a latent construct (such as personality or temperament; see key terms in the glossary for definitions), and is generally something that is *inferred* from a series of measurements rather than measured directly (Budaev 1998). It is therefore important that the adequacies of these measurements are evaluated against some sort of fundamental criteria, in support of the potential accuracy of the inferences that are subsequently being made. In psychological assessment, these two fundamental criteria are validity and reliability (e.g. see APA 1999).

1.1.4.1 Validity:

Described as a 'unified concept' that requires multiple sources of evidence in relation to the specific inferences that can be made from a particular test (Messick 1990), test validity ultimately refers to the meaningfulness, appropriateness and utility of measures (APA 1999).

1.1.4.1.1 Construct validity:

First presented by Cronbach & Meehl (1955), construct validity (the ability of operationally defined measures to reflect attributes that relate to a theorised concept or construct) is argued to be the overarching form of validity which subsumes all other individual aspects of validity (Messick 1975). In determining construct validity, the consideration of individual aspects of validity is however important and provides information in relation to potential test limitations and the types of inferences that can be made from tests (Messick 1995). Several of these important aspects of validity are discussed below.

1.1.4.1.1.1 Content validity:

Content validity assesses the relevance or representativeness of the test in relation to the individual measures contained within it, and to the inferences that are to be drawn from the test (Messick 1990). An important aspect of content validity, ‘face validity’ refers to the subjective assessment of the degree to which measures would appear to be measuring the trait or variable for which they are designed (Taylor and Mills 2006).

1.1.4.1.1.2 Discriminant and convergent validity:

Introduced by Campbell and Fiske (1959) such types of validity refer to the degree to which multiple measures that are theoretically related actually correlate (convergent validity) and those that are not theoretically related do not (discriminant validity) (e.g. see Goodloe & Borchelt 1998, Serpell & Hsu 2001). It is suggested that construct validity is often assessed specifically through discriminant and convergent validity (e.g. see Taylor and Mills 2006) and as such these types of validity may be considered as being particularly instrumental in their value.

1.1.4.1.1.3 Criterion validity:

For any type of behavioural assessment that is designed to be used in one context (e.g. a rehoming centre) with the expectation that it will be able to predict future behavioural outcomes within another (e.g. the home), determining the predictive validity of such measures is crucial (e.g. see Messick 1995, Taylor and Mills 2006). Criterion validity refers to the extent to which the developed test relates to some other (generally external) measurement criterion and is thus used to infer the predictive validity of a test in relation to its primary aims (i.e. what the test was designed to measure). With regards to temperament tests for 'working animals' the external criterion often used is that of pre-existing 'performance tests' rated by experienced judges (e.g. Svartberg 2002, Sinn *et al* 2010), for companion animals, this is normally owner reports of behaviour (e.g. Ledger 1997, Netto and Planta 1997, Hennessy *et al* 2001, van den Berg *et al*. 2003, Siegford *et al* 2003, Svartberg 2005,).

1.1.4.1.1.3.1 Sensitivity and specificity:

Sensitivity and specificity are often used to determine the general predictive validity of a test in relation to the ability of its measures to correctly predict true positives (sensitivity) (i.e. individuals exhibiting a specific type of behaviour or trait; e.g. see van de Borg *et al* 2011) and true negatives (specificity) (i.e. individuals not exhibiting a behaviour/trait; e.g. see Christensen *et al* 2011). Such information can be particularly useful in identifying the potential limitations of the test in relation to the strength of predictions and inferences that can be made from it.

1.1.4.2 Reliability:

One of the key aspects of a behavioural trait is that it displays elements of context and temporal stability, thus any tools that are designed to measure trait constructs must use methods that are able to effectively demonstrate such consistencies. It is therefore important that during the development of tests the reliability of measures are rigorously assessed to ensure that they are free from potential measurement errors, as well as to determine the intrinsic variability of the behaviour of individuals in relation to the measures selected (e.g. repeatability/stability). It has been argued that in regards to temperament/personality tests, reliability represents an integral aspect in relation to the overall validity of a test (e.g. Messick 1990, Taylor and Mills 2006).

1.1.4.2.1 Intra and inter observer reliability:

In the majority of cases, test reliability is most commonly assessed in relation to observer/rater reliability, where levels of agreement between different (*inter*) observers (e.g. see Goodloe and Borchelt 1998, Feaver *et al* 1986, Turner *et al* 1986, Slater *et al* 2013b, Gartner *et al* 2014), and to a much lesser degree, the same (*intra*) observer (e.g. see Diesel *et al* 2008, Olmos and Turner 2008) are determined. These are important aspects of reliability which help to assess potential human-error associated with measurement, as well as the level of general-user robustness.

1.1.4.2.2 Intra-individual and context stability:

Intra-individual stability is another important aspect of reliability which accounts for the fact that test results should be sufficiently repeatable when the same individual is rated or tested under the same conditions over short as well as longer periods of time (i.e. test re-test and temporal/longitudinal stability) (see Svartberg *et al* 2005, Riemer *et al* 2014). Additionally, the assessment of context stability helps to determine how much a test and its measures can be generalized for use *across* different external environments (e.g. see Messick 1990), as well as provide indication of how consistently a type of behaviour occurs in different contexts or across environmental landscapes *within* individuals. Both of these measures are therefore important in the identification of behavioural tendencies that are differentiable from context-specific responses (see Bell 2007, Dingemanse *et al* 2010).

1.1.5 Previous methods of assessment of individual differences in *F. silvestris* and their limitations in relation to reliability and validity

1.1.5.1 Questionnaire ratings:

Observer ratings can be particularly useful as they allow integration of multimodal, cross-situational and cross-temporal information (e.g. Gosling 1998, Lloyd *et al* 2007, Gartner and Weiss 2013, Gartner *et al* 2014), and can thus be of elucidative value in describing constructs that are inherently difficult to measure experimentally (such as temperament or personality) (Meagher 2009). Such approaches however are not without their limitations, and whilst inter-rater reliability tends to be the aspect of test validity most often assessed, the reliability of such behavioural components/items can vary considerably (e.g. in the Scottish Wildcat reliability correlation coefficients ranged from 0.10 for ‘quitting’ to 0.89 for ‘aggressive to conspecifics’ (Gartner and Weiss 2013)), and in the domestic cat from 0.07 for ‘fearful of conspecifics’ to 0.73 for ‘aggressive towards people’ (Gartner *et al* 2014). Furthermore, items that are reliable in one felid species are not necessarily reliable in others, with no clear ecological or biological reason for such cross-species variability apparent. For example, the item ‘smart’ was deemed reliable in captive Cheetahs (Wielebnowski 1999), and captive Scottish Wildcats (Gartner and Weiss 2012) but not in captive Snow Leopards (Gartner and Powell 2012), whilst ‘friendly towards people’ was reliable in Snow Leopards (Gartner and Powell 2012) and Scottish Wildcats (Gartner and Weiss 2012) but not in Cheetahs (Wielebnowski 1999), and finally ‘fearful of conspecifics’ was reliable in Scottish Wildcats (Gartner and Weiss 2012), but not domestic cats (Gartner *et al* 2014)). Whether this variability in item reliability is the product of the species or other aspects of the external environment is unknown but potentially questions the general validity of the items as measures of personality.

In relation to the assessment of items relevant to human-sociability in the domestic cat, some studies have indicated good levels (i.e. correlations of 0.80 or above) of inter-rater reliability for the various behavioural components measured (Feaver *et al* 1986, Turner *et al* 1986, Wedl *et al* 2001, Slater *et al* 2013b, Gartner *et al* 2014), whilst others have failed to mention whether reliability assessments were even performed (Gosling & Bonnenburg 1998, Lee *et al* 2007), and in all cases, no studies assessed item ratings for *intra*-rater reliability or longitudinal stability.

Whilst various studies using questionnaire methods have demonstrated face validity of the behavioural aspects of interest, (i.e. via data reduction techniques that indicate convergent and discriminant relationships between items that are theoretically related or opposed) (e.g. Wedl *et al* 2001, Slater *et al* 2013b), this has not been stated explicitly. And additionally, the convergent validity with other different types of measures that should theoretically relate the same underpinning behavioural construct have been assessed in some (Feaver *et al* 1986, Wedl *et al* 2001) but not all cases (e.g. Gosling & Bonnenburg 1998, Slater *et al* 2013a&c).

1.1.5.2 Behavioural measures:

Whilst directly observable measures (such as the latency, frequency or duration of 'real-time' behavioural responses) may appear individually less explanatory than observer ratings based on an overall impression, when taken collectively, they may help to describe an underlying construct without relying on the (potentially) more subjective and unreliable impressions of people. Using individual behavioural measures may also facilitate more precise mapping of behaviour at a biological level.

In the assessment of human-sociability, various behavioural measures taken in several previous studies have demonstrated aspects of construct validity by indicating good levels of convergent validity with other types of measurements, such as observer ratings (Feaver *et al* 1986, Wedl *et al* 2001), other behavioural test scenarios (Siegford *et al* 2003), or other genetic/environmental factors (e.g. McCune 1995). Several studies have also indicated good temporal stability of certain measures within a specific context (e.g. Meier and Turner 1985, Lowe and Bradshaw 2001), as well as across contexts (Siegford *et al* 2003), although in others, temporal stability of behaviour has not been assessed (Lee *et al* 1983, Bradshaw and Cook 1996, Wedl *et al* 2011), and in general the reliability of the measures over social and environmental gradients has been neglected. Such limitations thus make it difficult to determine whether behavioural variation observed within a population in one context represents useful general information in relation to underlying traits, or is just the product of methodological artefact.

In several cases, whilst a specific behavioural test was performed, behavioural responses were recorded via the subjective assessment of a test-person (i.e. a behavioural response was deemed 'acceptable' or 'unacceptable' (Lee *et al* 1983, Siegford *et al* 2003)), and in neither case was evidence of inter or intra-rater reliability provided. Even when direct observations of cats have been made during experimental testing, inter-observer reliability has not always been assessed (e.g. Bradshaw and Cook 1996, Reisner *et al* 1994).

Finally, in relation to assessments that have been designed intentionally for use in a specific environment (such as the rehoming centre) in order to predict future behaviour (e.g. see Siegford *et al* 2003, Slater *et al* 2013a-c) within the home, only one of these studies assessed the predictive validity (or criterion validity) of the intended measures (Siegford *et al* 2003).

1.1.6 The importance of practicality in behavioural tests

In their application, it is important that behavioural tests are 'fit for purpose' and as such their feasibility of use within the intended environment for which they were designed should be assessed. Whilst a test may be considered sufficiently valid, if it is not practical, then its general utility may be substantially limited. In the rehoming environment for example, test practicality is a particularly important factor because many centres may be operating at full capacity (Clark *et al* 2012, Stavisky *et al* 2012), and under limited resources (e.g. time, staff, funding etc.).

1.1.6.1 Practical limitations of previous measures in the domestic cat:

For questionnaire ratings, whilst good levels of inter- rater reliability have previously been reported, (e.g. Feaver *et al* 1986, Turner *et al* 1986, Slater *et al* 2013b), the amount of time necessary for people to spend with the cat prior to providing ratings was either unspecified (Turner *et al* 1986), or was for a substantial period of time (for example three months (Feaver *et al* 1986), or between one month and potentially 'years' (Slater *et al* 2013b)). As such, the practical application of these methods in various contexts (e.g. veterinary and rehoming centres) may be relatively limited, considering that the average stay for a cat in the rehoming environment may be less than a month (based on personal communications with the 'Joint Charities Feline Behaviour Group' (attended by major UK feline rehoming centre and welfare organisations), but see also Gourkow and Fraser 2006). Behavioural tests are also not without their practical limitations. Some of the previous 'interactive' tests performed on domestic cats have required protocols that could potentially be detrimental to the cats' welfare as well as to the safety of the test person involved. Such methods are thus not practical for use within the rehoming environment (e.g. 'grabbing the cats' tail and pulling with firm steady pressure'; Lee *et al* 1983, Siegford *et al* 2003). Whilst other tests may offer less stressful alternatives, they may be equally unsuitable for use because of the amount of time they take to perform (for example in McCune's (1995) study, protocols required cats to be observed over a total of six occasions, lasting one hour in total, with an additional thirty minutes of habituation time).

1.1.7 Human-animal interaction and temperament:

In relation to human-animal interactions, individual temperament may be an important feature and has thus been studied in a range of (in particular) domesticated species. In livestock, traits such as lower levels of aggressiveness, fearfulness or environmental sensitivity (e.g. see Grandin 1993, Lanier *et al* 2000, D'Eath *et al* 2009) have all been associated with a greater amenability to handling, and as such may be preferred or even selected for. Similarly in pets, the behavioural responses of individuals towards people may be one of the most important factors in their selection (Weiss *et al* 2012). For example lower levels of fearfulness (Wells and Hepper 2000) and aggressive behaviour (e.g. Reisner *et al* 1994, Salman *et al* 2000) and higher levels of friendliness towards humans (Gourkow and Fraser 2006) may not only be more desirable but potentially also predictive of reduced future relinquishment (e.g. New *et al* 2000, Salman *et al* 2000, Wells and Hepper 2000, Mondelli *et al* 2004, Kwan *et al* 2013).

However, whilst the temperament of the individual animal may be important in relation to the human-animal relationship, such dyadic interactions are inherently also influenced by the behaviour and temperament of the human. Evidence from various species would suggest that the way humans interact with animals may impact upon their subsequent behaviour and responses towards people (which could in turn affect the persons' perception of the animal) (e.g. see Boivinet et *al* 2000, Wedl *et al* 2001, Waiblinger *et al* 2002, Balckwell *et al* 2008, Rooney & Cowan 2011). Indeed, studies would suggest that the perceptions and expectations people have towards their pets can also affect the nature of the human-pet relationship as well as the likelihood of relinquishment (Patronek *et al* 1996a,b, Serpell 1996, Adamelli *et al* 2005, Curb *et al* 2013, Meyer and Forkman 2014). Such evidence would thus suggest that the behavioural features of the human as well as that of the animal are both important contributors to aspects of human-animal relationship.

1.1.8 The domestic cat in the rehoming centre:

It is estimated that here are around ten million pet cats within the UK (Murray *et al* 2010), with around thirty percent of this population changing ownership via rehoming organisations during their lifetime (Pet Food Manufacturers Association Annual Report 2014). In a recent study sampling less than half of all UK rehoming organisations, a total of 156,826 cats were found to enter in to their care within a single year (Stavisky *et al* 2012). The same study also suggested that more than half of these organisations had waiting lists that often exceeded their actual capacity (Stavisky *et al* 2012). Rehoming centres are thus burdened with providing care for a substantial proportion of the total UK cat population, often beyond their physical capabilities.

Unfortunately however, the rehoming centre may not represent an optimal environment for cats and may negatively impact upon various aspects of their wellbeing (see Bannasch and Foley 2005, McCobb et al 2005, Edwards *et al* 2008, Tanaka *et al* 2012, Finka *et al* 2014), perhaps particularly so when demand exceeds optimal capacity and resources are limited. Increased length of stay within such environments has been associated with the amplification and transmission of various infectious diseases (e.g. Bannasch and Foley 2005, Edwards *et al* 2008) as well as increased stress (Kessler and Turner 1997,1999, Ottoway and Hawkins 2003, McCobb *et al* 2005, Gourkow and Fraser 2006). Cats considered less social towards humans may find the rehoming environment particularly stressful (see Finka *et al* 2014), but may take longer to be rehomed (Gourkow and Fraser 2006) and may thus be at greatest risk of compromised wellbeing.

The average length of stay in UK rehoming centres is suggested to be slightly less than one month (based on personal communications with the 'Joint Charities Feline Behaviour Group' (attended by major UK feline rehoming centre and welfare organisations), but see also Gourkow and Fraser 2006)). However, in reality (particularly in "no kill" centres), there is often no maximum length of stay for individuals, and evidence would suggest that many cats can stay within such environments for indefinite periods of time (see Feaver *et al* 1986, Slater *et al* 2013b), often not being considered 'ready' or 'suitable' for adoption (Personal communications with the 'Joint Charities Feline Behaviour Group').

Given such issues, a tool that facilitates the practical assessment of cats and helps to identify those that are *not* suitable to enter in to the general rehoming population quickly (supporting minimal holding periods and optimal management of individuals), may help to limit the potential for detrimental welfare effects during periods of housing. A reduced length of stay per cat also enables rehoming centres to optimise their resources and increase annual 'turnover', effectively helping more cats each year.

A recent study of 555 rehoming centres that were surveyed found that only fifteen percent had formal methods to behaviourally assess cats within their care, and to identify those unsuitable for domestic living as a pet (Slater *et al* 2010). These findings would thus suggest that there is a substantial need for a useful and practical means of behavioural assessment that can be used in such environments.

1.1.9 Conclusion:

Many studies claiming to assess aspects of cat's temperament have failed to provide either a clear definition for the traits which they are intending to measure or a suitable theoretical framework in relation to the specific methodologies used. Providing such definitions however may not only help to justify the choice of methodology, but also facilitate a more precise or incisive approach to the study of individual differences. Additionally, considering individual variation at a biological level may greatly ease in cross-study comparisons.

In developing a test that is 'fit for purpose', it is important that the measures within the test are rigorously assessed for their validity and reliability as well as their practicality within the intended environment. Where such factors have not been demonstrated, the general utility of tests cannot be properly determined.

In assessing the temperament of individuals with the intention being to gauge their future 'sociability' towards humans, (and ultimately their suitability to interact sociably with humans in a domestic setting), it is thus important to understand how aspects of the human may impact upon the cat-human relationship, and potentially affect the perceived suitability of an individual, either independently of or in combination with the relative temperament of the cat.

Cats within rehoming centres may particularly benefit from reliable, valid and practical forms of behavioural assessment that enables rapid processing of individuals and facilitates the identification of appropriate post-centre outcomes for each individual. Such cats therefore represent a suitable population for the development of tests to assess human sociability.

1.2 Part 2: Theoretical framework for the study of human-sociability in domestic cats

1.2.1 General theoretical approach:

It is argued that previous temperament tests developed for use in cats using human psychology based constructs are often of limited biological relevance to the domestic cat and to factors relevant to the cat-human relationship in everyday contexts (e.g. see Gartner *et al* 2014). Many studies have also lacked any specific underlying theoretical structure during the development and subsequent interpretation of their tests, even though they purport to assess a complex (and inherently concept-driven) paradigm such as temperament (e.g. see Turner *et al* 1986, Bradshaw and Cook 1996, Durr and Smith 1997, Lowe and Bradshaw 2000, Siegford, *et al* 2003, Iki *et al* 2011). However it is argued that the use of (relevant) theoretical approaches may aid in the practical development and interpretation of a collection of proposed measures, and can be particularly useful when the construct and content validity of a test model is to be assessed, and where tests are subject to a level of reduction or refinement. For such reasons, a more biologically grounded approach to the assessment of temperament is proposed, using a framework based on the modular view of affect, discussed below.

1.2.2 Temperament and affective processes:

The regulation of behavioural tendency is argued to have a specific neurobiological underpinning that effects 'percept-based habits and skills' (Cloninger 1994), and various studies have explored the link between temperament and affective processes (e.g. Rothbart and Bates 1998, Rothbart *et al* 2000, Elloit & Thrash 2002, 2010, Réale *et al* 2007, Rothbart 2007). In such cases, basic levels of affect have been described in relation to approach/avoid or positive/negative activation (i.e. the Behavioural Activation and Behavioural Inhibition Systems (BAS and BIS) (Gray 1982) (cited by Rothbart *et al* 2000), see also Elliot & Thrash 2002, 2010, Sheppard and Mills 2002).

However, it is argued that the systems regulating fundamental approach/avoid responses may represent a 'complex taxonomy' of emotions that operate in relation to specific stimuli and contexts (i.e. the dislike of food is mediated separately from the dislike of pain, and the desire to mate separately from the urge to play (Panksepp 1998)).

Thus it is possible that a more incisive approach to affect-based studies of behavioural tendency that incorporates a more ‘complex taxonomy’ of emotional systems, may provide a more precise analysis of motivational states of affect, onto which specific traits and their proposed measures of assessment can be mapped. In this way, the modular view of affect (such as that presented by Panksepp 1988), (where behavioural systems are largely linked to emotional reactions), can be extended to incorporate the longitudinal stability of behavioural features hypothesised to relate to such reactions, thus providing a potentially suitable biological framework for the study of behavioural tendency.

Other models (principally developed for the psychological study of emotion in humans) such as the ‘Conceptual act model’ proposed by Barrett *et al* 2007 suggest the existence of a basic mammalian system of core affect of either positive or negative valence and associated arousal, and a potentially non-linearly occurring conceptual system for the processing of specific emotions. Whilst such models would oppose the ‘natural kinds’ approach to the study of emotions (e.g. see Panksepp 2007 and Izard 2007), given the complexity of the human-mammalian brain, it is uncertain whether non-human mammals (such as the domestic cat) share a similar emotion-processing conceptual system where emotions are both cognitively and socially constructed, as is proposed by this model. Whilst not necessarily fully conclusive, there is also an abundance of neurobehavioral data in non-human animals to support the existence of core operating systems that when directly stimulated cause differential emotional responses (Panksepp 1998). The modular view of affect as proposed by Panksepp is thus thought to represent a more suitable model for the study of individual traits in cats, based on the activation tendency of separate core emotional systems in the brain.

1.2.3 Proposed Biological framework for the assessment of human-sociability in the domestic cat:

1.2.3.1 Affective neuroscience:

Panksepp (1998) suggests the existence of several genetically dictated primary affective processes (or emotional operating systems) within the brain, which control the behaviour associated with specific or general types of stimuli and are shared by all mammals, e.g. a SEEKING system which is associated with the emotional response to incentives in the environment and a PANIC system associated with the loss of an attachment figure. The defining characteristics of an emotional process according to Panksepp are:

1. Circuits have a genetic basis for responding to biologically significant unconditional stimuli
2. Circuits organise behaviour through the regulation of biologically based autonomic, hormonal and motor subroutines
3. Circuits change the sensitivity of relevant sensory systems
4. Activity outlasts the precipitating circumstances
5. Circuits can come under the control of conditional stimuli
6. Circuits have bidirectional interactions with other cognitive processes of the brain

It is suggested that such operating systems originate within primitive subcortical regions of the brain. Of interest and particular relevance to this research are the core processes of FEAR, SEEKING and RAGE, associated with the acquisition or avoidance of environmental resources or stimuli**.** The FEAR circuit runs between the central amygdala and the periaqueductal gray (PAG) of the midbrain. Anxiety may arise from a mild arousal of the FEAR circuitry, with behavioural manifestations characterised 'largely by behavioural inhibition components', whereas manifestations of intense fear are characterised 'commonly by active flight' (Panksepp 1998). SEEKING is described as an 'appetitive motivational system', concentrated within the extended lateral hypothalamic corridor within the hypothalamus. This system is thought to be associated with the 'positive anticipation' or simply the 'wanting' (Panksepp 1998) of a resource. The core of the RAGE system is thought to run from the medial amygdaloidal areas, down to the medial hypothalamus, and then to specific locations within the PAG of the midbrain. This emotional system is thought to mediate 'affective attack' (or self-preserving types of aggressive responses) within individuals, and may have mutually inhibitory interactions with SEEKING circuits within the brain.

This neurobiological perspective of emotional systems not only provides a solid scientific basis to the evaluation of animal behaviour, but also allows the generation of testable hypotheses to allow their differentiation. It has been proposed (Leventhal and Scherer 1987) that there are four components to an emotional response, which may be inferred from external measurement: the cognitive appraisal of relevant stimuli, the arousal that it causes and associated changes in action tendency and the communication of this response. Thus careful observation of behaviour in specific circumstances may be used to triangulate evidence of different forms of emotional arousal. This may be particularly important when trying to evaluate a response such as aggression (which is of particular interest in the current study).

Aggression is neither a unitary nor unidimensional phenomenon (Panksepp 1998), and may have several very different environmental and cerebral antecedents. Aggressive styles of behaviour may occur in a variety of very different contexts, including during predation (e.g. SEEKING), inter-male and sexual conflict (e.g. SEEKING/RAGE), as well as in situations where individuals must actively protect themselves from harm (e.g. FEAR/RAGE), or where various external frustrations are exerted upon them (e.g. RAGE). In relation to the cat, these different forms of arousal should be associated with different features in the associated components (i.e. behavioural responses) used to triangulate evidence for the emotion.

1.2.3.2 Identified traits of interest to current research and their predicted biological underpinning:

Because it is important to provide clear operational definitions for the constructs that tests are designed to measure, this was the first initial process in the development of a suitable framework for the assessment of human-sociability in cats. Using aspects of the proposed biological framework outlined above, ‘sociability’ and the ‘aggressive response’ were critically deconstructed into biologically based traits that could then be mapped against relevant underpinning core emotional process. These traits were hypothesised to be key in the mediation of ‘sociable’ behavioural responses towards humans (see Table 1.1).

Table 1.1 Summary Table representing fundamental traits considered to be important elements in both 'human-sociability' and the 'aggressive response' in the domestic cat, their proposed operational definitions and relevance to core emotional processes of interest.

Individual 'traits'	Definition	Potential emotional states/processing systems involved sensu Panksepp 1998	Relevance of trait
Sociability	The tolerance of proximity to others, and a willingness or desire to interact with others	SEEKING RAGE	Potential important mitigators of the manifestation of "human-sociability" in cats
Boldness	A neophilia with the absence of fear	FEAR SEEKING	
Gregariousness	(The combination of both sociability and boldness): The active seeking out of the company of others (either known or unknown)	SEEKING FEAR RAGE	
Frustration reactivity	A negative emotional predisposition associated with the denial of an incentive, the denial of control or when expectations are not met.	SEEKING RAGE	Potential important mitigator of the "aggressive response" in cats
Fearfulness	A negative emotional predisposition associated with a threat or presence of an aversive stimulus.	FEAR	

1.2.3.3 Proposed methods to assess traits of interest

Whilst previous Electro stimulation Stimulation of the Brain (ESB) research in the domestic cat would suggest that specific behavioural responses can be produced from the stimulation of specific 'emotional circuitry' (see Panksepp 1998) (thus suggesting the existence of discrete affect-based systems), such experiments were performed in laboratory conditions and thus can be criticised for their lack of ecological relevance (Barrett *et al* 2007). In addition, the affective experience of this stimulation remains unknown. An alternative but equally empirical (as well as more ethical and practical) approach is instead proposed, whereby the study of affect-linked behavioural responses are observed via their induction in a range of ecologically relevant contexts. For such an approach, the standardisation of test contexts is required, particularly if behavioural responses are observed largely in cat-human interactive situations (as is necessary in the assessment of socially-based traits), given that previous studies indicate various attributes of humans as well as the general context in which interactions takes place may differentially affect subsequent behavioural responses (McCune 1992, 1995, Mertens and Turner 1988, Podberscek *et al* 1991).

Whilst traditionally methodological approaches in the assessment of behavioural expression in non-human animals have utilised behavioural coding and/or trait ratings (see Gosling 2001), other methods exist (for example Free Choice Profiling (FCP), e.g. Wemelsfelder *et al* 2000, Walker *et al* 2010). However using such techniques (which give observers complete choice over the descriptions attributed to individual animals), the differentiation between 'emotional expression' and behavioural styles may be unclear (see Walker *et al* 2010), potentially making it difficult to understand or isolate the underpinning emotional motivation for a specific behavioural response (i.e. is the cat behaving aggressively because it is afraid or frustrated?). This presents a substantial issue when it may be necessary to identify suitable environmental or behavioural modifications for individuals that are based on the behavioural assessments carried out, which hinge upon identifying the underlying cause of a behavioural response or style of behaviour.

For such reasons, the initial assessment models developed utilised standardised test scenarios based on 'every day' types of contexts a cat would likely be exposed to when held in a rehoming centre. Specific individual behavioural measures (that could be directly mapped against the emotional process and traits of interest) were also preferred over non-empirical descriptive observations of spontaneous behaviour.

1.2.4 Part 3: PhD project aims & objectives:

The ultimate goal of this PhD was to provide a way to assess which cats are most amenable to integrating socially in the domestic environment, focusing on the concept of ‘human-sociability’ and the individual traits predicted to be relevant to this construct. This approach uses aspects of affective neuroscience (*sensu* Panksepp 1998) to provide a clear neurobiological framework for the study of individual differences in cats, and explores the utility of developed measures in relation to their validity, reliability and feasibility for use in a rehoming centre context.

The following specific aims and objectives of the PhD were identified:

Aim 1: To assess individual differences relating to ‘human sociability' in cats using a solid neurobiological framework, achieved by;

- Deconstructing the concept of ‘human sociability’ into more fundamental biological traits, based on the hypothesis that this is a construct that may represent the interaction between multiple individual neurobehavioural traits or elements and emotional predispositions (Chapter 1).
- Evaluating the behaviour of individuals at the level of related emotional processes; by exposing cats to contexts associated with the potential induction of different emotional states, and identifying important test measures within these contexts (Chapter 2).

Aim 2: Determine which of the identified behavioural test measures are;

(i) Valid and reliable indicators of traits relating to ‘human sociability’.

(ii) Practical and feasible for use in the rehoming centre environment.

Achieved by;

- (i) Examining the effects of various factors (e.g. both temporal and context (i.e. social attributes of a person) upon the consistency of behavioural responses of cats at a population level, and identifying measures that are most reliable and thus least affected by such factors (Chapters 2 & 3).

- (ii) Reducing the number of behavioural measures necessary whilst still being able to adequately differentiate between individuals based on meaningful aspects of the traits identified in Aim 1 (Chapters 2 & 3).
- (for both i and ii) Assessing the test measures for their reliability/generalizability across different establishments and cat populations (Chapter 3).
- (for both i and ii) Identifying limitations of the developed test models and exploring the potential for additional/alternative reliable methods that may be useful in relation to Aim 2 (Chapters 4 & 5).
- (i) Developing measures that can be used as an 'external criterion' in order to assess the predictive validity of the final test model in relation to human perception of behaviour post-adoption (Chapter 6 Part 1).

Aim 3: Assess factors relevant to owner 'satisfaction' post-adoption by;

- Determining whether the final test model developed during Aim 2 is able to predict owner satisfaction (Chapter 6 Part 2).
- Determining which individual aspects of owner reported behaviours are *most* important in relation to owner satisfaction (Chapter 7).
- Determining if post-adoption owner satisfaction can be predicted based on pre-adoption owner 'ideals (Chapter 7).

2 Chapter 2 - Experiment 1: Development and refinement of behavioural tests

2.1 Introduction:

Having identified potentially important behavioural traits and associated core emotional processes (as outlined in Chapter 1), the next stage was to develop tests predicted to be associated with the induction of the different emotional states (e.g. FEAR, RAGE and SEEKING) within individuals, allowing traits to be assessed in these different emotional contexts. Certain components within the tests were designed to specifically assess elements relating to frustration reactivity (e.g. the RAGE system), whilst others parts of the tests were designed to assess human-sociability (SEEKING), boldness and fearfulness (e.g. FEAR).

One of the main underlying assumptions in relation to the identification of meaningful individual differences and underlying 'traits' within individuals is that the associated behavioural attributes remain comparatively consistent over contextual and temporal gradients (Stamps and Groothius 2009, Carter *et al* 2013). As such, the tests within this study were designed to allow the relative consistency of behavioural measures to be assessed across separate days as well as different external contexts. The aim of the tests were to assess aspects of sociability towards humans, thus tests were designed with the initial objective being to facilitate comparison of behavioural measures across social rather than physical dimensions. This involved the repeated testing of the same cats under replicated test conditions, as well as across variations in the social context (i.e. the familiarity of a person; familiar or unfamiliar, and the persons' interaction style towards the cat; passive or active). Previous research had suggested that these types of social factors may significantly influence the behavioural responses of cats, affecting how sociable they appear to behave towards people (e.g. McCune 1992, 1995, Mertens and Turner 1988, Podberscek *et al* 1991). Thus it was particularly important to this research to understand how these aspects of an individuals' external environment might influence the reliability of the current test measures being developed.

The main aim of this test development process was to initially identify and extract as many potentially useful individual behavioural measures from the tests as possible, and then to individually assess their reliability over (short-term) temporal and social gradients, in order to extract those most likely to relate to meaningful traits within cats.

To meet the practical requirements of the behavioural tests, the extracted reliable measures were then assessed for their further refinement, so that the final test model met the objectives as outlined in Chapter 1, fulfilling aspects of both reliability and feasibility criteria.

During Chapter 3, these refined measures were taken forwards and their robustness was then assessed on a larger scale with a focus on determining the (longer-term) temporal stability of measures as well as their generalizability across several different physical locations (e.g. rehoming environments), allowing a more comprehensive assessment of the validity of measures to be performed.

2.1.1 Chapter aims:

The aims of this chapter were thus to;

- Utilise the developed theoretical framework outlined in Chapter 1 to assist in the creation a series of standardised behavioural tests that could be practically executed within the rehoming environment, and then to identify individual behavioural measures that could be used to assess aspects of the emotional states and traits of interest.

- Refine these measures to create a reliable and practical model that is able to meaningfully differentiate between individuals based on such traits, again utilising the developed theoretical framework to facilitate biologically meaningful interpretation of measures.

2.2 Methods:

2.2.1 Test overview:

Tests were based around every day handling and husbandry scenarios a cat would likely encounter with a person in a rehoming/shelter environment (see Table 2.1 for brief summary of tests). These specific scenarios were chosen as they represented biologically relevant contexts within which to assess behavioural responses, and in this way would provide easily accessible sources of individual behavioural variation. Whilst certain test conditions could potentially induce FEAR in individuals, for ethical reasons, it was not the intention of tests to induce this state at a high level of intensity, nor directly though aversive means or 'threatening' situations. Furthermore, if individuals were to experience high FEAR arousal and were not able to effectively escape from a situation, this may in some cases have led to the manifestation of defensive aggressive responses, at which point fearfulness may no longer have been the most salient of emotions (i.e. the RAGE system also becomes highly stimulated (Panksepp 1998)). As such, 'fearfulness' in individuals was assessed via the presence of simple avoidant responses as well as the absence or delay of behavioural outputs. Similarly with RAGE, the tests were designed to induce this emotion at a relatively low level of intensity, primarily with an absence of FEAR, and in contexts associated with SEEKING (i.e. in the presence of positive resources such as food and positive human-attention). Thus both FEAR and RAGE were induced at levels similar to those the cat would normally experience, and on this basis the procedures used were therefore exempt from regulation under the Animals (Scientific Procedures) Act (1986), given the approval of their primary carers.

Table 2.1. Brief summary of experimental test conditions

Tests:	**Summary:**
1. Food withholding	A person stands in the cats unit with a bowl of food during morning feeding time. During the test, access to the food is briefly denied to the cat.
2. Human interaction & Play test	A person sits in a cat's pen and during different stages of the test either ignores the cat, strokes the cat or plays with the cat.
3. Emergence	A cat is put into a cat carrier, which is then placed in an unfamiliar room in which either a familiar or unfamiliar person is present. The person either ignores the cat (passive condition), or encourages interaction (active condition).
4. Less food than expected (quantity and quality reduced)	A person stands in a cat's pen and 'shows' the cat a bowl of wet food before placing a different bowl containing a few pieces of kibble on the floor instead. After a delay the bowls are switched and the cat is given the wet food. This is then briefly taken away and then put back again.

2.2.2 Test methodology

All tests followed a set of standardised protocols. Tests were repeated over four consecutive days, each day contained four separate test scenarios, with the first two days involving an unfamiliar person (myself), and the last two a familiar person (a member of rehoming staff) (see Table 2.2 for specific test orders). Cats were tested in their individual units where they were normally housed (Environment 1, Test 1, 2 and 4), as well as in a room that they had never been inside before (Environment 2, Test 3).

Each individual test was performed at approximately the same time each day for each cat. All familiar people used were full-time employees within the rehoming centre where testing was carried out. For a person to be classed as 'familiar', they had to have been the primary caretaker (i.e.

responsible for feeding, cleaning out and socialising) of the cat for at least one week prior to testing. Each individual cat received the same unfamiliar and familiar people during their specific tests, but several different familiar people were used during the whole test period, depending upon staff availability. All data were collected via a high definition video camera (Panasonic HC-V500), (see Figures 2.1-2.4 for images and diagrams of test area and experimental set up).

2.2.3 Test population

Tests were carried out on a population of cats (*n=26*) from one rehoming centre (Wood Green, the Animals Charity (WG)). The population comprised of eight males and 18 females, all except three females and one male were neutered. Ages ranged from 1-12 years with an average of 5.4 years. Cats were only included in the study if they were deemed healthy on the first day of the test period and were not identified as suffering from any medical conditions that would be likely to have a significant impact upon their behaviour. No cats were excluded from the study based purely on behavioural reasons, however if a cat could not be safely and calmly placed in the carrier (for example they attempted to bite or swipe the handler with claws unsheathed) for Test 3, the handling was halted and the cat was left in its unit and did not receive a Test 3 on that particular day. This resulted in five cats not receiving a Test 3 on at least one day over the total study period. Additionally, four cats missed a Test 1 on one of the study days, and another cat missed the last two full tests days due to a rescheduled veterinary procedure. Thus the total population that received the full battery of tests over the four-day study period consisted of 16 cats.

2.2.4 Test environments

Environment 1. (Tests 1, 2 and 4))

Each cat was housed individually in a unit comprising of a small inner raised compartment (inner unit) approximately a metre from the ground, and larger floor to ceiling outer unit. Inner and outer units were connected by way of a hatch door containing an opaque plastic window, as well as a cat flap with a ramp attached, leading down to the outer unit. All inner units contained beds and hiding places, and all outer units contained a cat igloo (or similar) with soft material inside as a place for the cat to hide, and another igloo containing a litter tray. These were positioned along the back wall of the outer unit, located underneath the overhang of the inner unit. All Feeding and Human interaction tests (Tests 1, 2 and 4) took place in the cats' outer units (henceforth referred to as the Test area). Other extra 'enrichment' items located in the test area (such as scratching posts, toys, logs, feeding devices, extra litter trays and beds) varied between each cats unit, but all these items were quietly removed preceding each test period and then replaced afterwards, so that all that remained during testing were the two cat igloos. A video camera mounted on a tripod was placed in the corridor adjacent to the test area. The wire mesh door that connected the test area to an external corridor was left open to allow ease of filming, and a clear Perspex sheet was placed in the doorway to prevent/discourage cats from exiting the test area into the corridor, at the same time allowing a clear view of the test area for filming (see Figure 2.1).

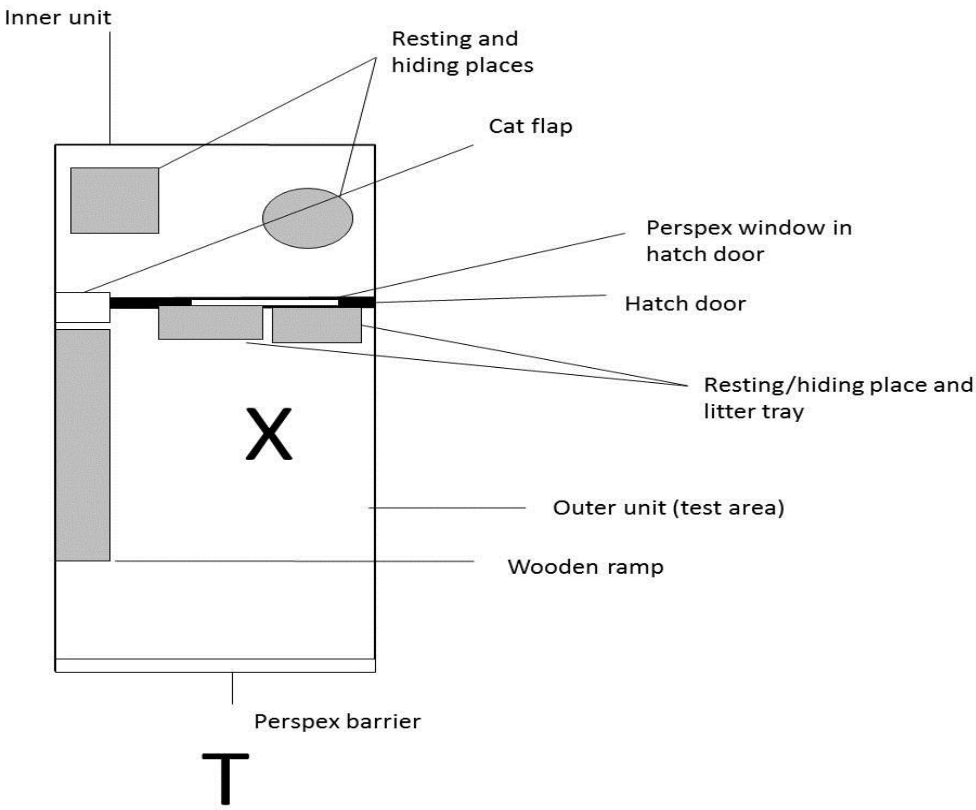

Figure 2.1 Plan of the individual housing units. **X** represents the approximate location of the test person during tests, and **T** the location of the tripod and camera, facing in to the test area. All feeding and interaction tests were performed in the outer unit (test area).

Figure 2.2 Environment 1: View of test area and experimental set-up used during ‘Food withholding’ and ‘Less food than expected’ tests (Tests 1 &4).

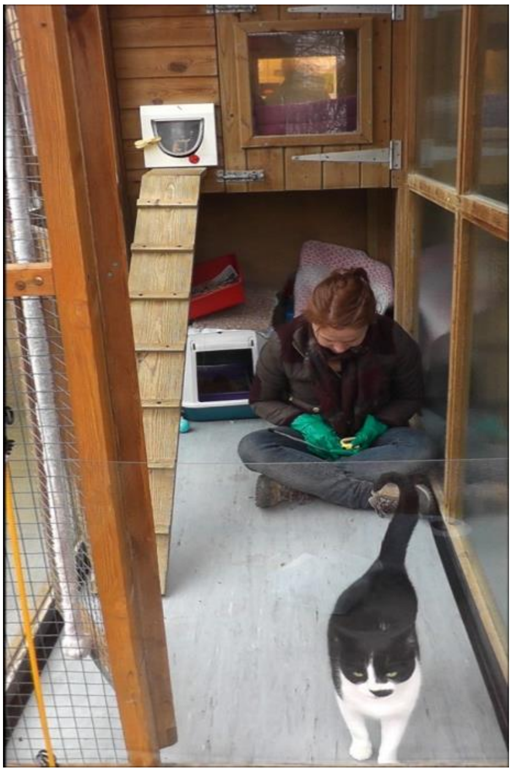

Figure 2.3 Environment 1: View of test area and experimental set-up used during ‘Human interaction and play’ tests (Test 2).

Environment 2. (Test 3)

Environment 2 was used to provide a novel setting for each Emergence test (Test 3). It consisted of a large portable cabin located in a quiet area approximately 10 meters from the main cattery that was free from visual and olfactory interference from other cats. The cabin was divided into two test areas (two separate rooms of roughly equal size – side A and side B), separated by a thin wall and door. During the testing period, side A and B were used alternately for testing each day so that the test room remained as ‘novel’ as possible for the duration of the study, controlling for potential habituation effects and their influence on the behavioural responses of cats. Windows within the test areas were covered to control for external visual disturbance. The experimental test area consisted of a corridor (approximately four meters long and 1.5 metres wide) made out of several plastic rectangle barriers approximately 70cm high. One end of the corridor was enclosed apart from a hatch door that could be programmed to vertically slide open after a short delay to reveal a square opening, slightly larger than the opening to a cat carrier. The other end of the corridor was open, providing access to the room outside of the test area, as well as an area that was covered and dark, (providing a hiding place for the cat).

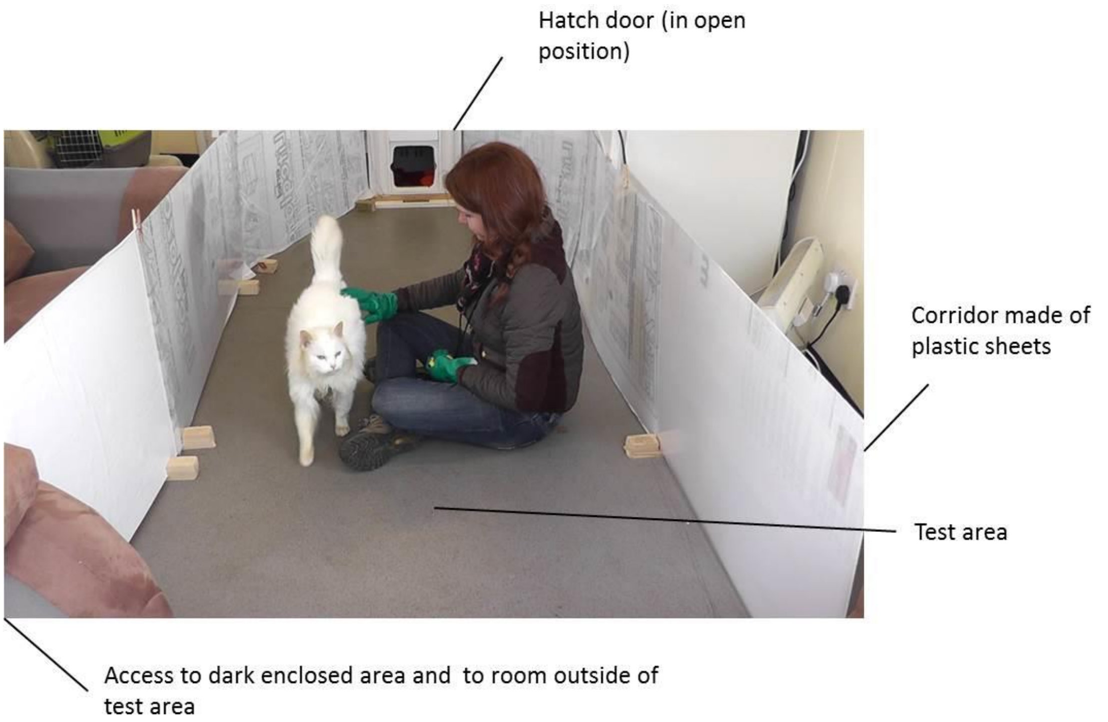

Figure 2.4. Environment 2: View of test area and experimental set-up used for all Emergence tests (test 3).

2.2.5 Test protocols

Test 1: Food withholding

Pre-test:

If test cats were in their inside unit and did not venture into the test area by the time the person was ready to commence the test, the cat was allowed an extra two minute period to emerge before the tests detailed below commenced. This was to allow cats that may have been sleeping prior to the start of the test, or those that would normally spend most of their time in the inner unit, to have extra time and gentle encouragement to venture in to the outer unit

For the first minute, the person stood sideways on, with their right side facing the opaque hatch (at a distance of approximately 40 cm), their back touching the wall of the unit and holding the bowl of food at waist height. The person behaved passively, looked down, and ignored the cat. At the end of the first minute, the person fully opened the hatch door, and then resumed their initial position, the hatch door now behind them. The person called “Hello Cat” and briefly ‘showed’ the cat the food (moving it slightly towards where the cat was located before lowering back to waist height again). After waiting 30 seconds they then repeated the above procedure, and finally resumed position until two minutes had passed. The following commenced either at the point when the cat ventured out into the test area during the two minutes, or at the end of the two minute period.

Test:

i) The person stood in the same position as in the above protocol, holding a food bowl containing a normal sized portion of the cat’s usual wet food at waist height. A plastic transparent lid with small circular holes drilled in it was attached to the top of the food bowl, so that visual and olfactory cues associated with the food were present, but access to the food was prevented. At the start of the test, the person called “Hello cat”, and then looked down, towards the floor and ignored the cat for two minutes.

ii) The food bowl was then placed on the floor approximately 50 cm in front of the persons feet, the transparent lid still attached to the bowl, and the bowl secured to the floor using sticking tape. As the bowl was placed on the floor, the person said “there you go” and then resumed their previous standing position, ignoring the cat for a further two minutes.

iii) After this time, the plastic lid covering the food was removed so that the cat had access to the food, the person again saying “there you go”. The person then resumed their standing position, ignoring the cat, for a final 30 seconds until the test ended at four minutes 30 seconds.

Test 2: Human interaction & play

Pre –test:

Pre- test procedure was similar to that performed in Test 1, for any cats not already in the test area. For the first minute, the person stood sideways on (their right side) next to the opaque hatch, with their back touching the wall of the unit. The person behaved passively, looked down, and ignored the cat. At the end of minute one, the person fully opened the hatch door, and then resumed their initial position, the hatch door now behind them. The person called “Hello Cat” and briefly offered the cat the fingers of their right hand, palm facing down, wiggling them in the direction of where the cat was located. The person’s hand was then removed and placed by their side. After waiting 30 seconds this procedure was repeated, until the end of minute two. The test commenced either at the point where the cat ventured out into the test area during the two minutes, or at the end of the two minute period.

Test:

Part (1)Human interaction:

(i) The person sat cross-legged on the floor in the test area, their back facing the direction of the hatch door, at a distance of approximately 40 cm away. The person had their right hand in contact with their right knee, palm facing down. At the start of the test the person orientated their head to face the cat (without making direct eye contact) and called out “hello cat”, wiggling their fingers for approximately five seconds. If the cat was in range (in touching reach of fingers) and stationary, the person could scratch/tickle the nearest part of the cat, if the cat was moving past the person and was in range, the person could stroke the cat as it moved past, following the direction of head to tail.

(ii) *Cat is ignored for two minutes:* After five seconds, the person withdrew their hand, looked into their lap and ignored the cat for two minutes.

(iii) *Interaction is encouraged for one minute*: The person then looked in the direction of the cat (without making direct eye contact), called “Hello cat”, placing their right hand back on their right knee, palm facing down, and wiggled their fingers. If the cat was in range (in touching reach of fingers) and stationary, the person could scratch/tickle the nearest part of the cat, if the cat was moving past the person and was in range, the person could stroke the cat as it moved past, following the direction of head to tail. If the cat moved around during this part of the test, the person orientated their head in the direction of the cat, but did not at any point engage in direct eye contact with the cat. Whenever the person wasn't actively touching the cat, they continued to wiggle their fingers. The person's right hand remained in contact with their knee at all times. This process continued for a duration of 60 seconds, with the person calling "hello cat" again after the initial 30 seconds. Part (1) ended at three minutes.

Part (2)Play:

i) Following on from part (1), the person produced a 30 cm rod with feathers attached to its end, which they wiggled on the ground in front of the cat for a duration of five seconds (or until the cat was fully engaged with the rod if less than five seconds).

ii) The person then abruptly stopped play and tucked the rod into their lap so that the feathered part was no longer visible. The person looked into their lap for a period of 30 seconds, ignoring the cat.

iii) The procedure of play, its abrupt end and ignoring the cat for 30 seconds was then repeated twice more. Part (2) ended at four minutes 30 seconds.

During these tests, the person wore plastic gloves to protect themselves from potential bites and scratches. These were thin enough to offer free-range of movement to the hand so that the person could stroke the cat in their usual way.

In between each test, the Perspex plastic sheet, rod toys and gloves were cleaned with the familiar biological cleaning agent used by the rehoming centre (Trigene Animal, Medimark) to remove cat scents and help control against any potential infectious disease spread.

Test 3: Emergence tests

Pre-test:

This initial test procedure was always carried out by the same unfamiliar person (myself).

Cats were initially given the choice to enter a cat carrier (with a floor-level opening) of their own accord, using a small food treat for encouragement. If this did not work then they were physically picked up and placed inside by being gently 'scooped' up from behind, with their whole body being supported by the person's arms and chest/torso. The cat was then placed head first into the carrier whilst still being fully supported. The carrier was lined with a small piece of bedding material taken from the cats unit.

This protocol was designed to reduce the potential of the person being injured by the cat, as well as to minimise the stress the cats may have experienced as a result of handling and being placed into a carrier. It was particularly important to minimise the potential negative arousal caused by this process in order for it not to impact upon the response of cats during the test procedure.

Once in the carrier, the cat was then transported to the test room with a thin cloth placed over the carrier to reduce transportation stress and to control for the potential influence of various visual stimuli pre-test. The carrier was placed behind the sliding hatch area and the carrier door was then removed so that the cat could exit the carrier into the test room as soon as the hatch door lifted upwards. The hatch was timed to open after a 90 second delay, allowing the person time to assume position at the other end of the test corridor. The test person (either familiar or unfamiliar) sat crossed-legged side-ways on, their right side facing the front of the carrier, at a distance of approximately two metres away.

Test:

Passive person test condition (day 1 unfamiliar and day 3 familiar):

For the duration of the test (four minutes from when the hatch slid open), the person was sat as described above, with their hands in their lap and gaze focused downwards. The person either read a book or interacted with their mobile phone (on silent) and ignored the cat. They did not look at or interact with the cat in anyway during the four minutes.

Active person test condition (day 2 unfamiliar and day 4 familiar):

During the active condition, the person had their right hand on their right knee, palm facing down. Upon the opening of the hatch, the person orientated their head to face the cat (without making direct eye contact) and called out "hello cat" in a normal friendly voice, at the same time they started wiggling the fingers of their right hand.

At any point during the four minute test period, if the cat was in range (in touching reach of the persons fingers) and stationary, the person could scratch/tickle the nearest part of the cat, if the cat was moving past the person and was in range, the person could stroke the cat as it moved past, following the direction of head to tail. If the cat moved around during the tests, the person orientated their head in the direction of the cat, but did not at any point engage in direct eye contact with the cat. Whenever the person was not actively touching the cat, they continued to wiggle their fingers. The person's right hand remained in contact with their knee at all times, and the above protocol continued for the duration of the test (four minutes), with the person calling out "hello cat" at 30 second intervals until minute four.

Between each test, the hatch, test area, plastic sheets and gloves were all cleaned with the same cleaning agent as used in the other tests. During the active test conditions, the person wore plastic gloves to protect themselves from potential bites and scratches. These were the same gloves that were used in Test 2.

Test 4: Less food than 'expected'

Pre-test:

The same test protocol was used as for Test 1 (see above).

Test:

Part (1): Less food than expected

i) The person stood in the same position as in other protocols, holding a food bowl containing a normal sized portion of the cat's usual wet food at waist height. Underneath this bowl was a second identical bowl, containing only three pieces of the cat's usual dry kibble. The full food portion was briefly 'shown' to the cat in such a way that it was able to see and smell but not eat the food.

ii) At this point the second bowl containing the kibble was then placed over the first bowl and firmly pressed down, and the stacked bowls were then placed on the floor approximately 50 cm in front of the person's feet, so that the cat only had access to the bowl containing the bowl with kibble in. As the bowl was placed on the floor, the person said “there you go” and then resumed their previous standing position, ignoring the cat for a further two minutes.

iii) After two minutes the person removed the top bowl from the stack, exposing the bowl containing the wet food beneath, saying “there you go”.

Part (2): Interference during testing

i) After part one, the person waited five seconds before reaching down and lifting the wet food bowl up out of the cat’s reach. The person resumed the initial upright position, ignoring the cat for five seconds before replacing the food back in its original position, saying “there you go”.

ii) The person then stood back in position until the test ended at two minutes 30 seconds.

2.2.6 Test orders

Each individual was exposed to the same test order sequence in order to control for order effects between subjects whilst keeping the required sample size practical. In this way, it was possible to control for day as a factor when making statistical comparisons. While this method inevitably introduces an order effect that cannot be separated out from the independent test effect, at the initial stage of measure development, this was believed to be an acceptable compromise (since the sequence of the sub tests might be considered part of the overall test), which greatly aided the practical delivery of this first experiment.

Furthermore, cats were always exposed to the unfamiliar person on the first two days of testing so that this person remained as unfamiliar as possible (this person was responsible for setting up test equipment in and outside each cat’s unit prior to each individual test, as well as placing cats into carriers throughout the duration of the test period, and would thus become more familiar over time).

Table 2.2 Order of test conditions over the four-day test period.

Day	Time of day	Test	Condition	Condition exposure day	Interaction style of person	Environment
1	am	Food withholding	unfamiliar person	1	n/a	1
		Human interaction & Play	unfamiliar person			1
	pm	Emergence	unfamiliar person		Passive	2 (Test side A)
		Less food than expected	unfamiliar person		n/a	1
2	am	Food withholding	unfamiliar person	2	n/a	1
		Human interaction & Play	unfamiliar person			1
	pm	Emergence	unfamiliar person		Active	2 (Test side B)
		Less food than expected	unfamiliar person		n/a	1
3	am	Food withholding	familiar person	1	n/a	1
		Human interaction & Play	familiar person			1
	pm	Emergence	familiar person		Passive	2 (Test side A)
		Less food than expected	familiar person		n/a	1
4	am	Food withholding	familiar person	2	n/a	1
		Human interaction & Play	familiar person			1
	pm	Emergence	familiar person		Active	2 (Test side B)
		Less food than expected	familiar person		n/a	1

2.2.7 Data analysis

Behavioural coding:

65 individual behavioural measures were initially identified across the four tests that mapped against potentially relevant core emotional processes. Measures covered aspects of these processes, in both physical and social contexts (see Table 2.3).

All video footage collected was then coded for these behavioural measures, using the software package *Noldus* Observer 10.5. Coded measures included latencies of the cat to perform certain behaviours (e.g. to emerge into the test area or to rub or sniff a person); frequencies of the occurrence of behaviours (e.g. number of rubs of a person or vocalisations ("meows") the cat performed) and also durations of behaviours (e.g. total time the cat spent in the test area or in contact with the person).

In preparation for statistical analysis, latency measures where a behaviour did not occur were allocated a ceiling value of the maximum test time. All test durations were the same length for each individual, therefore absolute values of measures (whether frequency, duration or latency) were used, rather than proportional data for statistical comparisons between subjects.

Table 2.3. Summary of initial the 65 individual behavioural measures that were assessed across the different test contexts, the emotional processes relevant to each measure, and whether they were hypothesised to involve social elements (S) (i.e. in relation to the human in an interactive capacity), or physical elements (P) (i.e. in relation to food, toys, the general external environment, or to humans in a non-interactive, non-social capacity).

Emotional processes involved in tests (S=social context , P=physical context				**Relevant behavioural measures from tests:**
Tests:	**SEEKING**	**RAGE**	**FEAR**	
Test 1: Food withholding	S,P		S	Latency to emerge into test area
	S		S	Duration of time cat looks at person's face
	S		S	Number of times cat looks at person's face
		S	S	Number of times cat looks away from persons face
		S	S	Number of times cat walks away from person
	S,P		S	Duration of time cat is absent from test area
	S,P	S,P		Number of vocalisations (meows)
	P		S	Latency to sniff covered food
	P			Number of times cat sniffs covered food
	P	P	S	Latency of cat to eat wet food
	P			Duration of time cat sniffs covered wet food

	SEEKING	RAGE	FEAR	Relevant behavioural measures from tests:
	P		S	Percentage of total time cat looks at food once presented
	P			Percentage of total time cat eats the wet food for
	P			Number of times cat looks at food
		P		Number of times cat looks away from food
		P		Number of times cat walks away from food
	S,P		S	Latency to sniff person
	S,P			Number of sniffing bouts on person
	S,P			Number of rubs on person
Test 2: Human interaction and play	S,P		S,P	Latency to emerge into test area
			S,P	Duration of time cat not in test area
	S	S		Duration of time cat spent in contact (touching) with person
	S		S	Duration of time cat looks at person's face
	S		S	Number of times cat looks at person's face
		S	S	Number of times cat looks away from person
		S	S	Number of times cat walks away from person
	S,P			Number of times a cat rubs a person
	S,P		S	Latency of cat to rub person
	S,P		S	Latency of cat to sniff person
	S,P			Number of times a cat sniffs a person

	SEEKING	RAGE	FEAR	Relevant behavioural measures from tests:
	P		S	Latency for cat to start to play with toy
	P			Number of times cat looks at toy
	P			Percentage of total time cat looks at toy for when present
	P			Duration of time cat interacts with toy
Test 3: Emergence	S,P		S,P	Latency to emerge from carrier (with all four feet)
	S,P			Duration of time spent in test area
	S,P		S	Latency of cat to make initial physical contact with person (e.g. sniff, rub or touch person with any other part of body)
	S,P		S	Latency of cat to first sniff person
	S,P		S	Latency of cat to first rub person
	SP			Number of times a cat approaches a person, ending in contact being made
	S	S		Duration of time cat spent in contact (touching) with person
	S,P		S,P	Latency of cats head to emerge from carrier (ears are outside of the carrier)
		S,P	P	Number of vocalisations (meows)
	S,P			Number of times cat sniffs a person
	S,P			Number of times cat rubs a person
Test 4: Less food than expected	S		S	Duration of time cat looks at person’s face
	S		S	Number of times cat looks at persons face

	SEEKING	RAGE	FEAR	Relevant behavioural measures from tests:
	S,P		S	Duration of time cat is absent from test area
		P		Number of times cat walks away from food
		P	S	Number of times cat looks away from food
		S	S	Number of times cat looks away from person
	P			Number of looks at food bowl
	P			Duration of time cat sniffs dry food
	P		S	Latency to sniff dry food
	P		S	Latency of cat to eat dry food
	P			Number of times cat sniffs dry food
	P	P	S	Latency to start eating wet food
	P	P		Percentage of time spent eating wet food
	P	P		Percentage of time cat looks at food once presented
	S,P		S	Latency of cat to rub person
	S,P		S	Latency of cat to sniff person
	P	P		Duration of time cat sniffs dry food
	S,P			Number of rubs on person
	S,P	S,P		Number of vocalisations (“meows”) during test
	P	P		Number of times cat paws at or pushes/moves food bowl around

2.2.8 Statistical analysis:

2.2.8.1 Overview:

Once all footage was coded and behavioural values obtained, the reliability of each behavioural test measure from each test was assessed using a two-phase analysis process. Refinement and further reduction of measures was then carried out during a final further two phases, with a review to retaining only the *necessary* robust measures of use.

2.2.8.1.1 Phases 1&2 - Assessing the reliability of test measures:

Whilst it is accepted that the nature of a behavioural response may change over different types of social and/or environmental gradients (e.g. see Dingemanse *et al* 2010), for a measure to be a potentially reliable indicator of temperament or underlying predisposition, at a group level it is important that these changes be easily predictable or quantifiable and thus not affected by external factors in relatively complex ways. The criteria used for determining the reliability of behavioural measures (outlined in Table 2.4) was developed in light of these principles.

Phase 1:

This assessed the degree to which measures were affected by

- The social context; the familiarity of the person (whether 'familiar' or 'unfamiliar' - all tests), and the person's interaction style (whether 'passive' or 'active' - Test 3 only),
- The 'condition exposure day' (day 1 or 2 of exposure to the 'familiar' or 'unfamiliar' conditions - Tests 1, 2 & 4).

Feeding (tests 1 & 4) and human interaction & play (test 2):

To test for the effects of the familiarity of the person (whether familiar or unfamiliar), and the day of exposure (i.e. either Day 1 or Day 2 for both the 'familiar' and 'unfamiliar' test days), as well as the interactions between these two factors, on the behavioural responses of cats, generalised linear mixed effects models (GLMMs) with Poisson error structures were used. Within these models, individual identity of each cat was treated as a random fixed effect.

Emergence (test 3):

The same statistical approach was used, however the factors tested within the model were the familiarity of the person (whether familiar or unfamiliar) and their interaction style (whether passive or active). Individual identity of the cat was again treated as a random fixed effect.

All analyses were carried out in R software (version 3.0.0) (R Development Core Team, 2013). The package *lme4* (Bates 2007) was used for the mixed effects models. Models were simplified using maximum likelihood fits, by the process of step-wise elimination of the least significant effects to produce the Minimum Adequate Models (MAMs) (Crawley 2007). Model diagnostics were performed to assess normality, heteroscedasticity and check for overdispersion.

Across all tests, if the average value of any frequency measure was < 2, the behaviour was considered too rare for practical consideration and statistical analysis was not undertaken. Data was initially summarised (Table 2.5) and inferences drawn from the patterns across tests. Measures were considered with regards to their quality and reliability based upon the exclusion criteria indicated in Table 2.4. Phase 1 was performed on all measures whilst phase 2 only the measures retained after phase 1.

Measures were removed if they met the exclusion criteria outlined in Table 2.4. To assess for significant effects of factors within the models, a probability threshold of P=0.05 was used. This value was considered acceptable for this initial developmental process because any decrease in P would increase the risk of concluding type II errors (an effect is present but it is not found), which in this case was less desirable than type I errors, (an effect is apparent but none is actually present) (see Neyman and Pearson 1992) since reliability of measures was determined via the absence rather than presence of an effect.

Phase 2:

This assessed the degree to which measures were reliable from correlation coefficients between the first and second day of repeated testing in both the familiar and unfamiliar conditions (Tests 1, 2 & 4). Coefficients were not possible to calculate for Test 3 due to the additional variation in interaction style of the person across days.

To test for the strength of linear relationships between the first and second day of testing for each behavioural measure, collective values of behaviours from the whole test population were totalled and their correlation coefficients calculated using the *cor* function in R (from the *stats* package). Measures taken from the familiar and unfamiliar person conditions were analysed separately. Measures were removed if they met the exclusion criteria outlined in Table 2.4.

Table 2.4: Exclusion criteria for test measures: Measures were excluded from the test model if they met any of the below criteria

Exclusion criteria:	
Phase 1: For Tests 1,2 &4	Any measures that were significantly affected by the day of condition exposure (either individually or as an interaction with another factor)
For Test 3	Any measures that were significantly affected by the interaction of two factors

	(i.e. both the familiarity of the person and their behaviour)
Phase 2 For Tests 1,2 &4	Measures that had weak correlations coefficients (< 0.6) between the first and second repeat test (both unfamiliar and familiar conditions were treated as separate tests).

2.2.8.1.2 Phases 3 & 4 – The refinement and interpretation of reliable test measures:

The focus of phases 3 & 4 was to reduce the number of remaining measures in order to increase the feasibility of the final test model, whilst still being able to meaningfully differentiate between individuals based on key aspects of identified underlying emotional processes. During phases 3 & 4 measures were removed if this did not significantly impact upon the predictive accuracy of the final test model.

Phase 3:

Hierarchical Cluster Analysis (HCA) was used to describe how behavioural measures (dendrograms based on the individual measures) as well as individual cats (dendrograms based on cat identity) clustered together. HCA approaches have previously been used in the creation of behavioural profiles for both humans and animals, via the classification of groups of measures (see Marzillier and Davey 2004) and groups of individuals (Tóth *et al* 2008) based on their behavioural outputs. This approach enables a practical method of data grouping via the building of a 'binary tree' where successive merging of similar groups of elements occurs, and facilitates easy visual inspection of the tree via the production of dendrograms. Dendrograms can then be 'cut' at a specific height in order to identify subsequent individual clusters of interest or relevance to the nature of the research question.

Hierarchical clustering is useful in the way that it holds less A priori assumptions about the nature of relationships between variables (as compared to a K-means approach for example), and does not require the number of clusters generated to be specified in advance. However, clusters produced through such an approach are not considered to be very stable, and a reduction in variables can have a substantial effect on the nature of future clusters. It is therefore important that where this approach is used as a method of measure refinement, the effect of data removal on subsequent clusters and their structure is taken in to consideration. In addition, the 'cutting' and following cluster identification is often a heuristic and somewhat subjective process (e.g. see Tóth *et al* 2008) and thus some form of standardisation for the selection of where the dendrogram is 'cut' is important, as is a suitable theoretical framework to justify the process of 'cutting' and subsequent interpretation of identified clusters (see Everitt *et al* 2001).

The information generated from this statistical approach was used to initially assess the associations between behavioural measures and their groupings in light of their predicted indications of different underlying emotional processes. Potentially redundant measures were identified from those which clustered together very similarly and as such were interpreted as not adding any extra level of behavioural detail to the overall clusters. To assess the general stability of clusters post data reduction, the effect of the exclusion of these potentially redundant measures was then evaluated on the relative clustering of individual cats within dendrograms based on the identity of each subject. If the exclusion of various measures had little impact upon the relative clustering of cats, their permanent removal could be considered acceptable, since cats were still being classified in the same way without these additional measures. Utilising the proposed theoretical framework (Chapter 1), initial measures-based and cat identity-based dendrograms were 'cut' at point where such a cut facilitated a practical and biologically meaningful interpretation of the subsequent clusters. However, to maintain an element of standardisation during the cutting process, where further dendrograms were created using smaller subsets of the same data, (to directly compare the effect of data removal on the structure of the dendrogram), the cuts were always performed at the same height as in the previous dendrogram.

Initially, all reliable behavioural measures from each test were considered for inclusion (see Table 2.7). Where repeat behavioural measures had been taken to assess reliability (i.e. tests 1, 2 & 4), the behavioural values from the first day of testing were used (e.g. unfamiliar day 1 and familiar day 1). Hierarchical Cluster Analyses (HCA) with Euclidian distancing (representing the geometric distance between two objects and being less affected by outliers within the data) were performed and dendrograms generated using the *hclust* function from the *stats* package (R Core Team 2013). The agglomerative method for hierarchical clustering (where each element is in a cluster of its own and is sequentially combined into larger clusters, based on the shortest distance between two elements or clusters) was used.

For the HCAs, an average linkage method (where the distance between two clusters is defined as the average distance between each element within a cluster, in relation to every element within other clusters) was specified. This link type represents a compromise between complete and single linkage and avoids the issue of 'chaining effects', where clusters are forced together based on their distance to a 'nearest neighbour', even though other elements within a cluster may be far apart (see Milligan and Cooper 1987).

In total, only 16 cats were included in this analysis (i.e. the cats that had received the full suite of tests on all days).

In order to standardise the data variation across all tests (a necessary prerequisite for the type of HCA used), values for each test measure were transformed from continuous to binary data. To aid in the transformation of data into binary format, histograms were plotted for the raw data to determine appropriate binary scores to assign to each individual cat for each behavioural measure taken. During this transformation, the following rules were used to partition the data into the binary categories:

- Frequency data: Whether a behaviour did or did not occur
- Duration data: When bimodally distributed, data were divided into two groups at the lowest point on the histogram, and individuals were assigned to one of the two groups. When data were unimodally distributed, the rules for frequency data were applied.
- Latency data: As for duration data

Phase 4:

Behavioural profiles for each cat were created based on information gathered from the 'Behavioural measures' (Figure 2.7) and 'Cat identity' dendrograms (Figures 2.6 a/b) of refined measures from phase 3. Cats were given four composite scores (one for each behaviour cluster, Figure 2.7), each score representing the collective number of times a behaviour located within a specific cluster had been performed, as well as a group score (either A or B) based on the nature of how individual cats clustered together (Figure 2.6). To provide a more sensitive picture of the potential variability between individuals, raw behaviour data scores rather than bimodal values were used (bimodal values had been used for the purpose of previous HCA analyses where the focus had been on the associations between behavioural measures rather than individuals). The use of raw scores required the exclusion of measures with latency values (due to their much larger scales). Whilst this lead to a total exclusion of five measures (one from cluster 3, and four from cluster 4), these measures generally shared very similar positions with many other measures within the dendrogram (see Figure 2.7) and thus their removal was considered acceptable. Individual cluster scores were then generated for each cat (see Tables in appendices 2.1-2.4 for breakdown of individual scores).

To test the strength of the cluster scores to accurately predict which group cats were likely to fall within (either group A or B), Linear Discriminant Analyses (LDA) (from the *MASS* package, R Core Development Team 2013) were performed using these profile scores. All profile score data was normalised using log transformations prior to LDA analysis.

Further refinement of individual behavioural measures could then be assessed by determining the effect of their removal on the accurate prediction (determined via further LDAs) of allocation of individuals to their respective cat group. This was the final stage of the refinement process. Measures were only removed if their removal improved the feasibility of the test model, without compromising the strength of relative cat-group predictions, or the stability of the structure of the individual behavioural test measures within the refined model (determined via further HCAs).

2.3 Results:

2.3.1 Phase 1&2:

General trends across tests:

A large proportion of the behavioural measures that were analysed were significantly affected by;

i) The day of exposure to the ‘familiar’ and ‘unfamiliar’ test conditions (either day 1 or day 2)

ii) The interaction between the familiarity of the person and the day of exposure (e.g. Test 2 – the number of looks in the direction of person's face, and the duration of time the cat spends in contact with the person (Table 2.5)),

or by;

The interaction between the familiarity of the person and their interaction style, (e.g. Test 3 - the latency of a cat to approach a person and the total number of times a cat sniffed a person (Table 2.5)),

or had;

iii) Weak correlations between the first and second day of testing within either the familiar or unfamiliar tests conditions (e.g. Test 2 – the number of times the cat looks at the toy in the familiar person condition (Table 2.6)).

Phase 1 results:

Table 2.5. Phase 1 results. Test results for all 65 behavioural test measures assessed in relation to the factors found to have a significant effect upon them (either as a single factor or as an interaction - denoted by the presence of an 'x' in the relevant column). Statistical results taken from GLMM ANOVA tests, using stepwise elimination of non-significant factors. Test statistics for factors retained within the Minimum Adequate Models (MAM's) are reported. Non-significant effects are only reported where the null model was accepted. Measures in bold were retained within the test model and underwent Phase 2 of the refinement process. A '-' within a column indicates where a single factor cannot be tested independently of other factors as it already exists as a significant factor within a two-way interaction in a particular model.

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Food withholding tests (Test 1)						
Duration cat not in test area during test	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 6.933 , df=1,5, p<0.01
Number of vocalisations ("meows") emitted by cat	**No effect**	**x**	**No effect**	**n/a**	**n/a**	**Familiarity** n=16, **x^2= 31.246, df=1,4, p<0.01**
Latency to sniff person	X	x	No effect	n/a	n/a	Day n=16, x^2= 57.395 , df=1,4 p<0.01, Familiarity n=16, x^2= 430.96 , df=1,4, p<0.01
Number of sniffing bouts on person	X	x	No effect	n/a	n/a	Day x^2= n=16, 5.3414 , df=1,4, p<0.05 Familiarity, n=16, x^2= 25.445 , df=1,4, p<0.01

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Latency to rub on person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2=102.2 , df=1,5, p<0.01
Number of rubs on person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2=4.9639 , df=1,5, p<0.05
Number of looks in the direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 =6.3193, df=1,5, p<0.05
Duration cat looks in direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 35.164, df=1,5, p<0.05
Latency of cat to emerge into test area	x	x	No effect	n/a	n/a	Day n=16, x^2= 7.7134 , df=1,4, p<0.01, Familiarity n=16, x^2= 35.598, df=1,4, p<0.01
Latency to sniff covered food	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 6.5585 df=1,5, p<0.05

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Latency if cat to eat wet food	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 8.429 df=1,5, p<0.01
Number of times cat sniffs covered food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 1.3457, df=1,5, p>0.05** **Day** n=16, **x^2 = 0.373, df=1,4 , p>0.05** **Familiarity** n=16, **x^2= 1.215 , df=1,4, p>0.05**
Duration of time cat sniffs covered wet food	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 18.137, df=1,5, p<0.01
Percentage of total time cat eats the wet food for	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 5.1666 , df=1,5, p<0.01
Number of looks at food bowl	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 0.9301, df=1,5, p>0.05,** **Day** n=16, **x^2 = 0.8682, df=1,4, p>0.05** **Familiarity** n=16, **x^2= 0.3634 df=1,4, p>0.05**

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Number of times cat walks away from person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 0.3237 , df=1,5, p>0.05** **Day** n=16, x^2 **= 0.0364 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 0.0364 , df=1,4, p>0.05**
Number of times cat looks away from person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 2.7411, df=1,5, p>0.05** **Day** n=16, x^2 **= 0.0022 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 0.3781 , df=1,4, p>0.05**
Number of times cat walks away from food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2**= 0.3237, df=1,5, p>0.05** **Day** n=16, x^2 **= 0.0364, df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 0.0364 , df=1,4, p>0.05**

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Number of times cat looks away from food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 0.3304 , df=1,5, p>0.05** **Day** n=16, **x^2 = 1.5903, df=1,4 , p>0.05** **Familiarity** n=16, **x^2= 2.8301 , df=1,4, p>0.05**
Percentage of total time cat looks at food once presented	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 4.0616, df=1,5, p>0.05
Human-Interaction & play (test 2):						
Latency for cat to start to play with toy	**No effect**	**x**	**No effect**	**n/a**	**n/a**	**Familiarity** n=16, **x^2 = 8.8183, df=1,4, p<0.05**
Duration of time cat plays with toy	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 7.6135, df=1,5, p<0.05
Percentage of total time cat looks at toy for when present	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 15.42, df=1,5, p<0.05

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Number of times cat looks away from person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **=0.0228, df=1,5, p>0.05** **Day** n=16, x^2 **=0.9869, df=1,4, p>0.05** **Familiarity** n=16, x^2**=2.4916,** ^{df}**=1,4, p>0.05**
Number of times cat walks away from person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **=0.0539 df=1,5, p>0.05** **Day** n=16, x^2 **=0.4052, df=1,4, p>0.05** **Familiarity** n=16, x^2**=3.0733,** ^{df}**=1,4, p>0.05**
Number of times cat looks at toy	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 0.0228 df=1,5, p>0.05** **Day** n=16, x^2 **=0.9869 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**=2.4916, df=1,4, p>0.05**
Duration of time cat not in test area	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 17.34 , df=1,5, p<0.001

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. ‘familiar’ versus ‘unfamiliar’)	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Duration of time cat spent looking in the direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x2=45.333, df=1,5 $p<0.05$
Duration of time cat spent in contact with person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 92.176 , df=1,5, $p<0.001$
Latency of cat to sniff person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 41.666, df=1,5, $p<0.001$
Latency of cat to enter into test area	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 29.537 , df=1,5, $p<0.001$
Latency of cat to rub person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2=183.19 , df=1, 5 $p<0.001$
Number of times a cat sniffed a person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 2.8133, df=1,5, $P>0.05$** **Familiarity** n=16, **x^2= 1.1555, df=1,4, $p>0.05$,** **Day** n=16, **x^2 = 0.109, df=1,4 $P>0.05$,**

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. ‘familiar’ versus ‘unfamiliar’)	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Number of times cat rubbed person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 1.4285, df=1,5, P>0.05** **Familiarity** n=16, **x^2= 1.2638, df=1,4, p>0.05** **Day** n=16, **x^2 = 0.3952, df=1,4, P>0.05**
Number of looks in the direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 =4.6131, df=1,5, p<0.05
Emergence (Test 3):						
Duration of time cat spends in test area	**n/a**	**x**	**n/a**	**x**	**No effect**	**Interaction style** n=16, **x^2=30.631, df=1,4, p<0.001** **Familiarity** n=16, **x^2= 18.357, df=1, 4, p<0.001,**
Duration of time cat in contact with person	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, x^{2}= 21.645, df=1,5, p<0.01

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. ‘familiar’ versus ‘unfamiliar’)	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Latency of cat to approach a person	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, x^2= 55.658, df=1,5, p<0.01
Number of approaches towards person, ending in contact	**n/a**	**No effect**	**n/a**	**x**	**No effect**	**Interaction style** n=16, **x^2=25.526, df=1,4 p<0.01**
Number of vocalizations (“meows”) emitted by cat	**n/a**	**No effect**	**n/a**	**No effect**	**No effect**	**Interaction style** n=16, **x^2 =2.3682, df=1,5, p>0.05** **Familiarity** n=16, **x^2= 2.3571, df=1,4 P>0.05** **Interaction style :Familiarity** n=16, **x^2 =2e-04, df=1,4, P>0.05**
Number of bouts sniffing at person	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, x^2= 6.8326 , df=1,5, p<0.05
Number of times a cat rubbed a person	**n/a**	**No effect**	**n/a**	**x**	**No effect**	**Interaction style** n=16, **x^2 =206.4, df=1,4, p<0.01**
Latency for cat's head to emerge from carrier	**n/a**	**No effect**	**n/a**	**x**	**No effect**	**Interaction style** n=16, **x^2= 6.8879 , df=1, 4p<0.001**

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Latency for all paws of cat to emerge from carrier	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, $x^{2=}$ 28.268, df=1,5, p<0.05
Latency of cat to sniff a person	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, x^2= 363.64, df=1,5, p<0.01
Latency of cat to rub a person	n/a	-	n/a	-	x	Familiarity: Interaction style n=16, $x^{2=}$ 6.2468, df=1,5, p<0.01
Less food than 'expected' (Test 4):						
Duration of time cat spends not in test area	**No effect**	**x**	**No effect**	**n/a**	**n/a**	**Familiarity** n=16, **x^2= 56.833, df=1,4, p<0.01**
Latency of cat to rub person	x	No effect	No effect	n/a	n/a	Day n=16, x^2 = 10.799, df=1,4, P<0.01
Latency of cat to sniff person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 11.674 , df=1,5, p<0.01

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Number of rubs on person	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 8.2945 , df=1, 5 $p<0.001$
Number of vocalisations ("meows") during test	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 9.9294 , df=1,5, $p<0.05$
Duration of time cat spends looking in direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 26.42, df=1,5, $p<0.05$
Number of looks in direction of person's face	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 26.42, df=1,5, $p<0.05$
Percentage of total time cat eats the wet food for	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 14.917, df=1,5, $p<0.01$

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Duration of time cat sniffs dry food	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2 = 50.096 df=1,5, p>0.01
Number of times cat paws at or pushes/moves food bowl around	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 9.5157 df=1,5, p>0.01
Frequency of times cat sniffs dry food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, **x^2 = 0.0409 df=1,5, p>0.05** **Day** n=16, **x^2 = 0.05, df=1,4 , p>0.05** **Familiarity** n=16, **x^2= 0.4925 , df=1,4, p>0.05**
Latency of cat to eat wet food	-	-	x	n/a	n/a	Familiarity: Day n=16, x^2= 23.24 df=1,5, p>0.05
Latency of cat to sniff dry	x	x	No effect	n/a	n/a	Day n=16, x^2 = 4.9956, df=1,4, p<0.05 Familiarity n=16, x^2= 37.193, df=1,4, p<0.01

Test measure:	**Day** (of exposure to condition)	**Familiarity** (of condition i.e. 'familiar' versus 'unfamiliar')	**Day: Familiarity**	**Interaction style** (of test person)	**Interaction style : Familiarity**	**Statistical Effects found**
Latency of cat to eat dry food	-	-	x	n/a	n/a	Familiarity: Day n=16, $x^2 = 4.4762$ df=1,5, $p<0.05$
Percentage of total time cat looks at food once presented	x	No effect	No effect	n/a	n/a	Day n=16, $x^2 = 36.949$, df=1,4 , $p<0.05$
Number of times cat walks away from food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 0.385 , df=1,5, p>0.05** **Day** n=16, x^2 **= 0.0769 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 1.4474 , df=1,4, p>0.05**
Number of times cat looks away from food	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 0.1178, df=1,5, p>0.05** **Day** n=16, x^2 **= 0.4275 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 1.386 , df=1,4, p>0.05**

Number of looks at food bowl	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 0.0125 , df=1,5, p>0.05** **Day** n=16, x^2 **= 0.4275, df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 0.1592 , df=1,4, p>0.05**
Number of times cat looks away from person	**No effect**	**No effect**	**No effect**	**n/a**	**n/a**	**Familiarity: Day** n=16, x^2 **= 1.3579 , df=1,5, p>0.05** **Day** n=16, x^2 **= 0.0645 , df=1,4 , p>0.05** **Familiarity** n=16, x^2**= 1.3076, df=1,4, p>0.05**

Phase 2 results:

Table 2.6. Pearson correlation coefficients between days 1 and 2 of exposure to test condition for both familiar and unfamiliar person conditions, for each measure retained during Phase 1 of the refinement process. Values calculated to the nearest 1dp. Measures that had weak correlations coefficients (< 0.6) were excluded at this point. Measures indicated in bold were retained within the test model and underwent further evaluation (i.e. phases 3 & 4).

Behavioural test measure:	**Correlation coefficients between day 1 & 2 for each condition (familiar and unfamiliar):**
Food withholding (Test 1):	
Number of times cat sniffs covered food	Unfamiliar: 0.5
	Familiar: 0.8
Number of times cat looks at food bowl	**Unfamiliar: 0.7**
	Familiar: 0.5
Number of times cat walks away from person	Unfamiliar: 0.4
	Familiar: 0.8
Number of times cat looks away from person	Unfamiliar: 1
	Familiar: 0.7
Number of times cat walks away from food	Unfamiliar: 0.3
	Familiar: 0.2
Number of times cat looks away from food	**Unfamiliar: 0.6**
	Familiar: 0.6
Human-Interaction & play (Test 2):	
Latency for cat to start to play with toy	Unfamiliar: 0.5
	Familiar: 0.6
Number of times cat looks away from	**Unfamiliar: 0.7**

person	Familiar: 0.4
Number of times cat walks away from person	**Unfamiliar: 0.7**
	Familiar: 0.9
Number of times cat looks at toy	**Unfamiliar: 0.6**
	Familiar: 0.1
Latency for cat to start to play with toy	Unfamiliar: 0.5
	Familiar: 0.6
Number of times a cat sniffed a person	**Unfamiliar : 0.8**
	Familiar: 0.5
Number of times cat rubbed person	**Unfamiliar: 0.8**
	Familiar: 0.9
Less food than 'expected' (Test 4):	
Duration of time cat spends not in test area	**Unfamiliar: 0.8**
	Familiar: 0.7
Number of times cat sniffs dry food	Unfamiliar: 0.4
	Familiar: 0.3
Number of times cat walks away from food	**Unfamiliar: 0.7**
	Familiar: 0.6
Number of times cat looks away from food	Unfamiliar: 0.5
	Familiar: 0.5
Number of looks at food bowl	**Unfamiliar: 0.6**
	Familiar: 0.6
Number of times cat looks away from person	Unfamiliar: 0.2
	Familiar: 0.5

Summary of reliable measures:

Table 2.7 Summary of the refined behavioural measures taken forward to Phase 3 of the refinement process, the influence of social factors upon each measure, and the relevant emotional processes (SEEKING, FEAR and RAGE, S= in a social context, P = in a physical context) the behaviours were predicted to measure aspects of.

Behavioural measures:	**Significant effect of factors:**		**Emotional processes: (Sensu Panksepp 1998)**			**Conditions used: (each condition becomes a separate individual behavioural measure)**
	Familiarity	**Interaction style**	**SEEKING**	**FEAR**	**RAGE**	
Food withholding tests (Test 1):						
Number of times cat sniffs covered food	No effect	n/a	P	-	P	Familiar
Number of looks at food bowl	No effect	n/a	P	-	P	Unfamiliar
Number of times cat walks away from person	No effect	n/a	P	-	S	Familiar
Number of times cat looks away from person	No effect	n/a	P	S	S	Familiar
Number of times cat looks away from food	No effect	n/a	S	-	P	Both conditions
Human-Interaction & play (test 2):						
Latency for cat to start to play with toy	X	n/a	P	S	P	Familiar
Number of times cat looks away from person	No effect	n/a	P	S	S	Unfamiliar
Number of times cat walks away from person	No effect	n/a	P	-	S	Both conditions
Number of times cat looks at toy	No effect	n/a	P	-	P	Unfamiliar
Number of times a cat sniffed a person	No effect	n/a	S,P	-	-	Unfamiliar

Number of times cat rubbed person	No effect	n/a	S,P	-	-	Both conditions
Emergence (test 3):						
Number of approaches towards person, ending in contact	No effect	x	S,P	-	-	All conditions (familiar/unfamiliar and active/passive)
Number of times a cat rubbed a person	No effect	x	S,P	-	-	All conditions (familiar/unfamiliar and active/passive)
Latency for cat's head to emerge from carrier	No effect	x	S,P	S,P	-	All conditions (familiar/unfamiliar and active/passive)
Number of times a cat vocalised "meowed"	No effect	No effect	S	-	S,P	All conditions (familiar/unfamiliar and active/passive)
Less food than 'expected' (test 4):						
Duration of time cat spends not in test area	x	n/a	S,P	S	-	Both conditions
Number of times cat walks away from food	No effect	n/a	S	-	P	Both conditions
Number of looks at food bowl	No effect	n/a	P	-	P	Both conditions

2.3.2 Phase 3 results, refinement and discussion:

2.3.2.1 Hierarchical Cluster Analysis:

A HCA dendrogram based on all the reliable individual behavioural test measures retained from Phase 2 (Model #1) was ‘cut’ horizontally at a point where several distinct clusters of measures could be identified (Clusters 1-3, Figure 2.5).

The vast majority of all measures were located within Cluster 2, with many of these measures sharing the same position within the cluster, making it difficult to interpret. Thus in order to aid interpretation, Cluster 2 was examined to assess whether there were any potentially redundant measures that would be removed.

All measures from Test 4 (those beginning with ‘pm_f_’ in the HCA dendrogram) were positioned within the right-hand branch of Cluster 2, and were mostly located relatively closely to each other, as well as to several measures from other tests. In general contrast to this, measures from Test 1 (beginning ‘am_f_’), Test 2 (beginning ‘i_’) and Test 3 (beginning ‘em_’) were comparatively more widely dispersed, either within or between the separate clusters. As such, Test 4 measures did not appear to add a useful extra source of behavioural variation within the data set and were therefore considered suitable for exclusion during Phase 3 of the refinement process. Examination of two ‘Cat identity’ dendrograms, one including Test 4 measures, and one where they had been excluded, showed the population clustered into two similar groups in each case (Group A and Group B, Figure 2.6 a) and b)). The relative positioning of individuals *within* the groups only changed for one individual of Group A (Bramble) (Figures 2.6 a) and b)). Therefore, it was concluded that the exclusion of Test 4 measures was acceptable.

Post removal of Test 4 measures, another dendrogram based on behavioural measures was produced (Model #2). This was again ‘cut’ horizontally at a point where several distinct clusters could be identified (Clusters 1-4, Figure 2.7). Measures within this new dendrogram were comparatively much more evenly distributed, and at this point, groups of measures were evaluated on the basis of the emotional processes hypothesised to be associated with each cluster (see Table 2.7 and Table 2.9).

Cluster 1: RAGE:-(Social context) (see Figure 2.7)

Cluster 1 was comprised entirely of vocalisation measures ("meows"). These measures were all taken during Test 3 which involved the exposure of cats to a novel environment where the individual was free to hide or explore the novel room if it wished, and depending on the condition interact with a person. It is hypothesised that this cluster is predominantly related to RAGE rather than FEAR, and potentially in a social rather than physical context, since meowing is largely affected by social reinforcement (for examples see Wedl *et al* 2011, Yeon *et al* 2011, Nicastro and Owren 2003, Schötz and van de Weijer 2014).

The inherent lack of (perceived) control over the external environment which the novel condition presents may for some cats be a frustrating experience, and whilst it is possible that this test may also induce FEAR, it is more plausible that fearful cats would inhibit vocalisations such as the "meow" rather than vocalise excessively (i.e. mild FEAR is characterised by behavioural inhibition and intense FEAR by escape behaviours, Panksepp 1998). Indeed a recent study by Gourkow *et al* (2014) found that inhibitory and avoidant types of behaviour such as 'hiding, flat postures, freeze, startle, crawl and retreat from humans' (potentially representing fearful cats) were all correlated with each other, but not with meowing. Persistent meowing was on the other hand associated with ' scanning, pacing and pushing, together with bouts of destructive behaviour, attempts to escape and redirected aggression' (Gourkow 2014), a collection of behaviours that are likely to be associated with frustration (i.e. RAGE). Similar behavioural findings were also suggested by McCune (1992) where confined cats that meowed excessively were also those that were destructive within their units and attempted to escape (again potentially indicative of frustration).

It is also hypothesised that the meows in the test contexts relate to social rather than physical aspects of RAGE. Evidence would suggest that the meow may serve a social function or purpose, with research supporting the hypothesis that the meow is influenced by 'human perceptual biases' and the process of socialisation (e.g. see Nicastro 2004, Yeon *et al* 2011, Schötz and van de Weijer 2014). Furthermore, meowing has also been documented in other potential social-RAGE situations where cats were exposed to unpredictable feeding routines and meowed excessively in the presence of their caretakers (Carlstead *et al* 1993).

Cats scoring highly for Cluster 1 are therefore predicted to be those with a more reactive RAGE system, especially in relevance to social contexts or situations.

Cluster 2: SEEKING:- (physical context) (see Figure 2.7)

Cluster 2 contains measures from Test 3 and includes the frequencies of rubbing and approaching both familiar and unfamiliar people, but only in the passive conditions. It is suggested that this cluster most closely reflects activation of the SEEKING system, and potentially predominantly in a physical rather than social context.

Whilst the measures within this cluster all involve the cat making contact with the person, they represent the contexts where social interaction with the person was very limited (the cat was ignored completely). It is possible that under these conditions, the person is perceived more as an object that can be 'investigated' or potentially scent marked (e.g. Feldman 1994) rather than a social subject to be interacted with.

Cats that score highly for Cluster 2 are predicted to be those that have an active SEEKING system, and may be keen to explore within novel physical environments.

Cluster 3: SEEKING:- (social context) (see Figure 2.7)

(RAGE):- (social context)

Cluster 3 contains a larger range of measures, including the frequency of various approach/interactive behaviours (e.g. approaching, rubbing and sniffing with familiar and unfamiliar people, Tests 2 and 3), as well as several withdraw/disengagement behaviours (e.g. the number of times a cat looks and walks away from a person, Tests 1 and 2).

It is suggested that this cluster primarily represents SEEKING in a social context (via the range of different interactive measures), and also social RAGE control (via the disengagement measures) but only in a secondary capacity - disengagement is as a functional consequence of potential RAGE activation, not necessarily an indication of active frustration aimed at acquiring a denied resource. For example, during the approach of and interaction with people, social aspects of the SEEKING system are engaged. If the cat becomes frustrated during this interaction (e.g. because during this part of the test the cat is being ignored, or the cat's expectations of interaction are not being adequately met in some other way), the point where the cat withdraws from the interaction may serve the purpose of avoiding or reducing current RAGE activation. Thus disengagement behaviours may signify the absence of RAGE at levels of a high intensity, rather than their presence.

Cats that score highly for Cluster 3 would therefore be expected to have an active social SEEKING system, often choosing to interact socially with people. They may also be the type of cat that responds to or manages frustration well by withdrawing from an interaction rather than remaining fixated on the social situation and responding aggressively for example.

Cluster 4: SEEKING:- (physical context) (see Figure 2.7)

(*RAGE): - (physical context)*

Cluster 4 contains a diverse range of measures across all three test conditions, predominantly those that relate to approach (e.g. Tests 1-3) and withdrawal (e.g. Test 1) from physical elements within the test (such as food). It is suggested that this cluster represents SEEKING in a physical context, and is also linked to physical RAGE but again only in a secondary capacity. The withdrawal from physical incentives such as food when they are desired but not accessible (e.g. during parts of Test 1) may function to manage or avoid further RAGE activation, rather than signify its presence per se.

Cats that score highly for Cluster 4 would be predicted to have an active SEEKING system, specifically in relation to physical incentives within the environment. They may also be the type of cat that responds to or manages physical resource-based frustration well by withdrawing from a situation rather than continually persisting with attempts to access the resource.

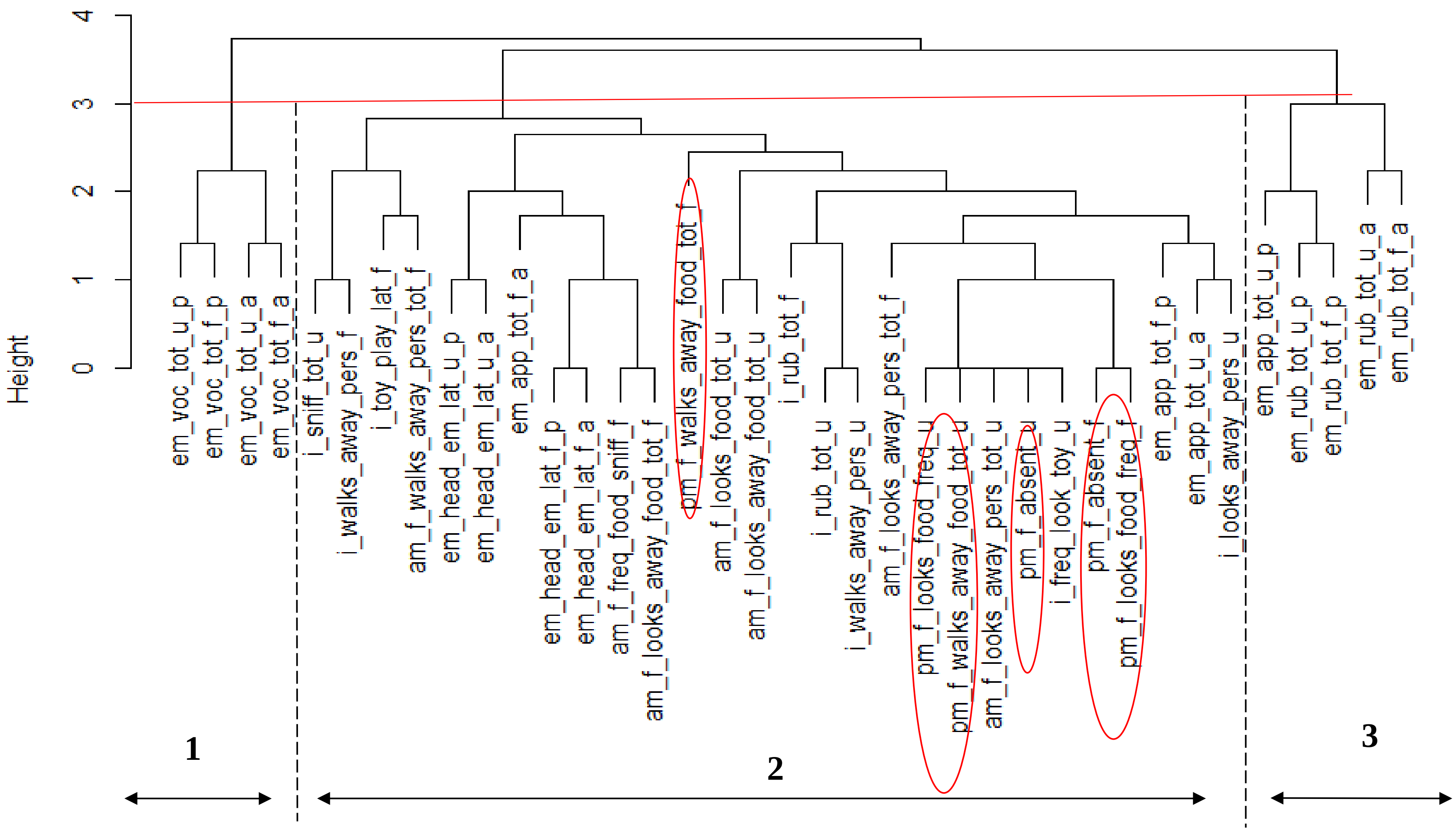

Figure 2.5 Model #1'Behavioural measures' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on all the refined behavioural measures from Phase 2 (Tests 1-4, listed in Table 2.7). Dendrogram of test measures produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from 37 individual behavioural measures across a population of 16 individuals. (See Table 2.8 for full description of each abbreviation). The central vertical black dotted lines represent the three main clusters that are apparent within the dendrogram (clusters 1, 2 & 3), whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters. Test measures circled in red are those from Test 4 that were removed during phase 3 of the refinement process.

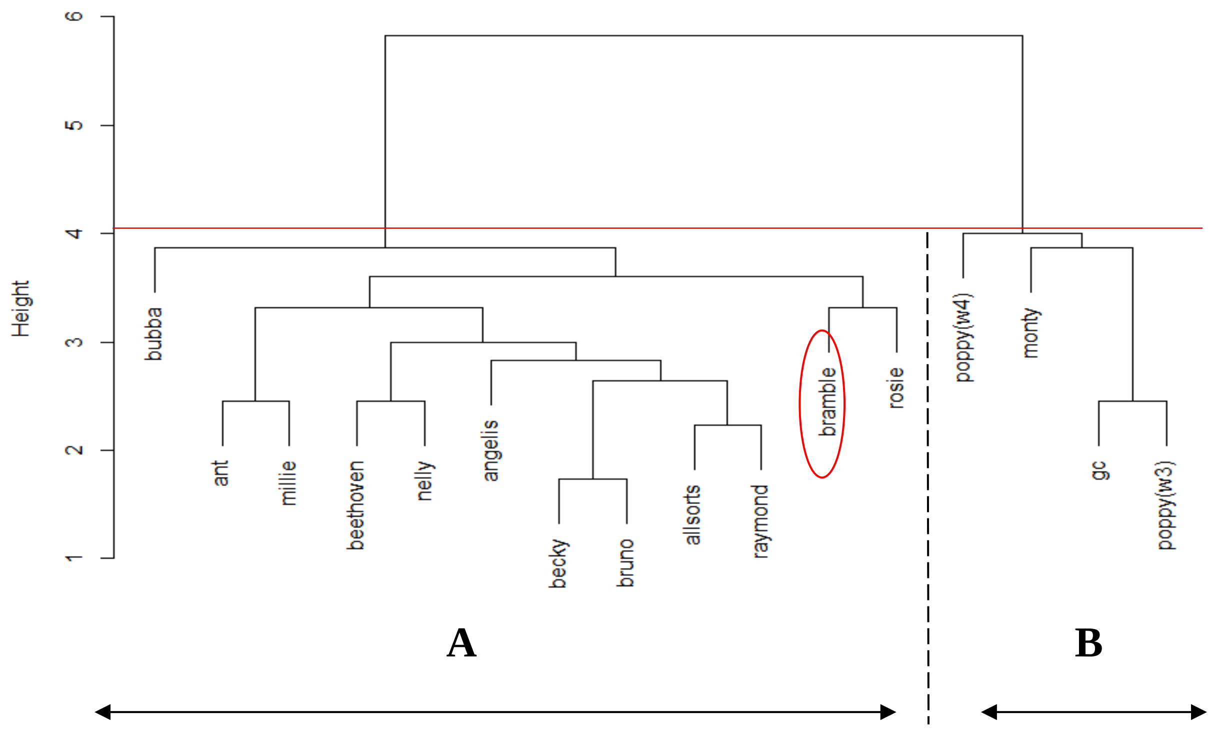

Figure 2.6. a) Model #1 'Cat identity' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on the refined behavioural measures from phase 2 (Listed in Table 2.8). Dendrogram of individual cat identity produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from 37 individual behavioural measures across a population of 16 individuals. Two separate grouping of individuals were identified; groups A and B.

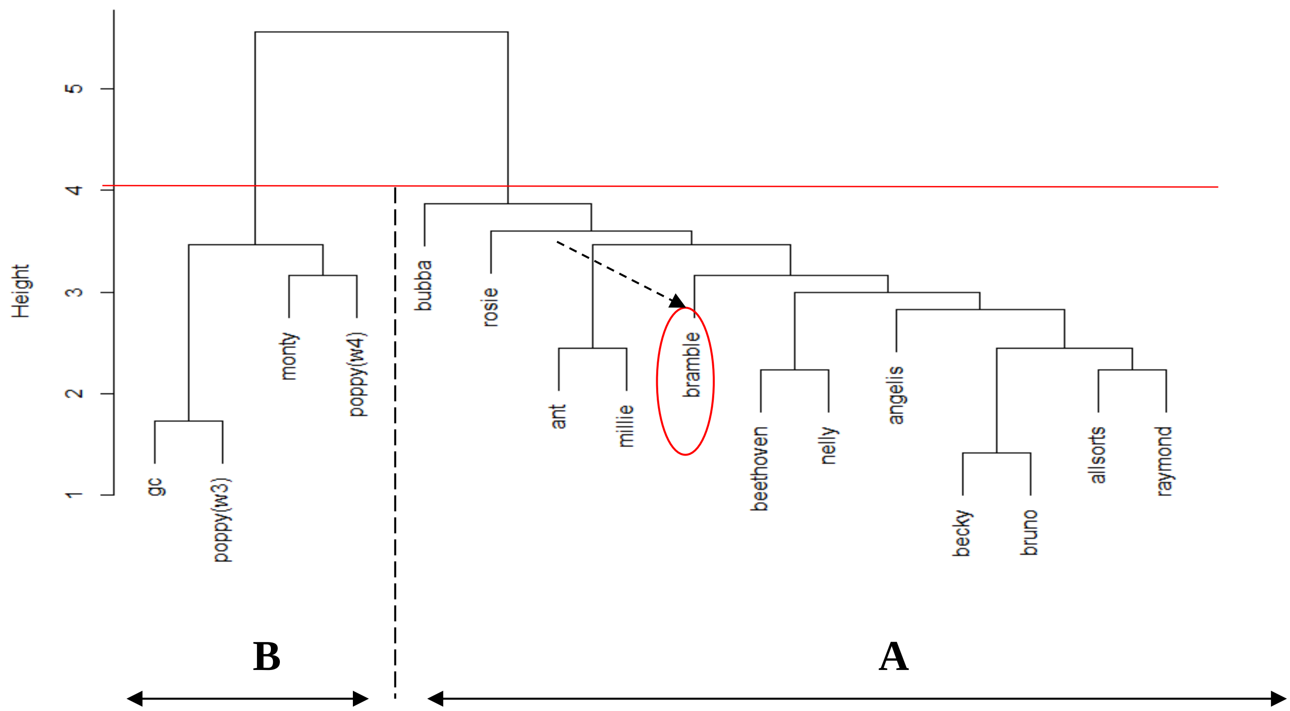

Figure 2.6. b) Model #2 'Cat identity' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on the refined behavioural measures post removal of Test 4 measures. Dendrogram of individual cat identity produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from 31 individual behavioural measures across a population of 16 individuals. Two separate grouping of individuals were identified; groups A and B.

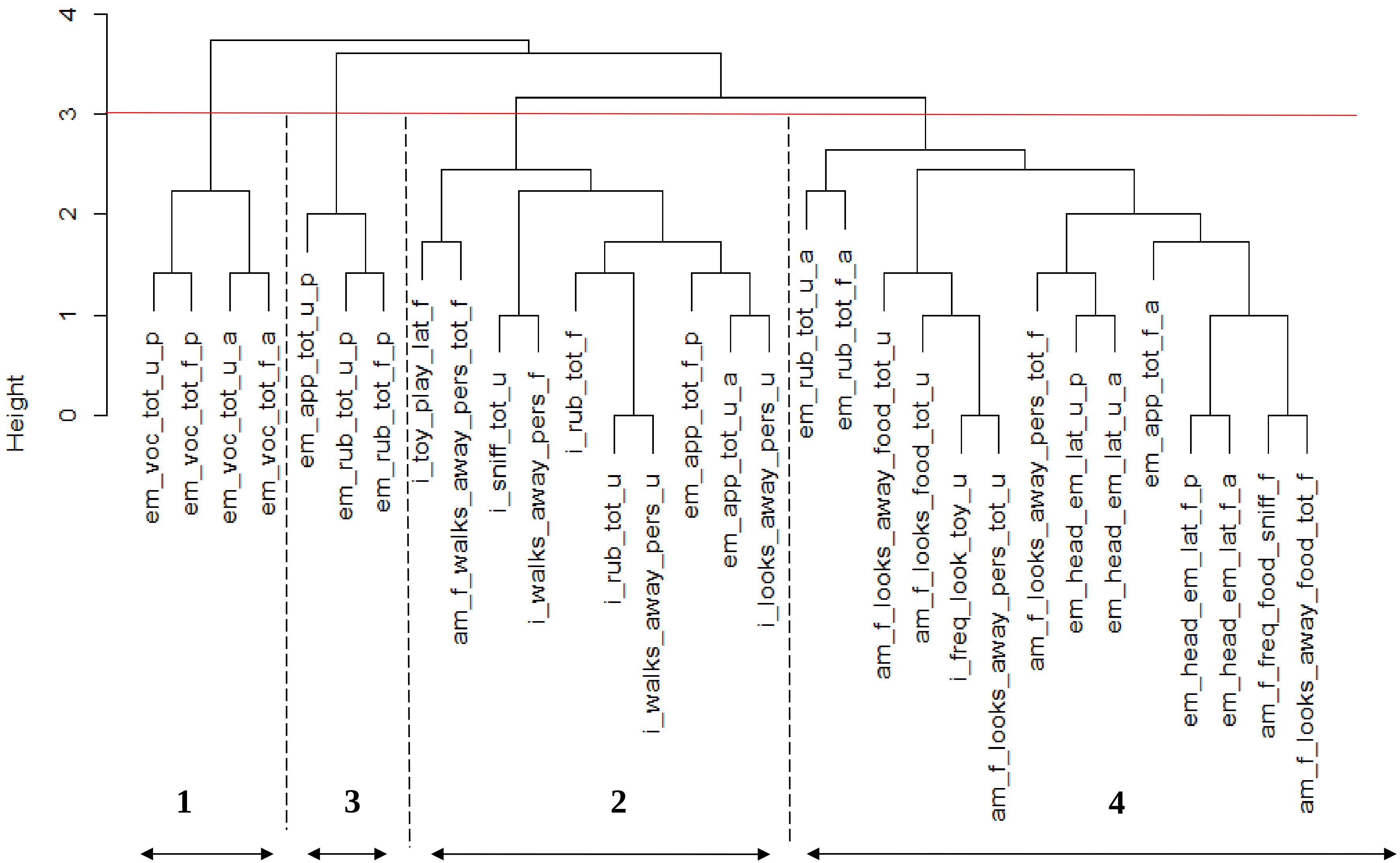

Figure 2.7 Model #2 'Behavioural measures' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on the refined measures from Test 1-3. Dendrogram produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from 31 individual behavioural measures across a population of 16 individuals. (See Table 2.8 for full description of each abbreviation). The central vertical black dotted lines represent the four main clusters that are apparent within the dendrogram (clusters 1, 2, 3 & 4), whilst the red horizontal line represents the height at which the dendrogram was 'cut'.

Table 2.8. List of all behaviour measure abbreviations from the HCA dendrograms (measures from all models), the specific test conditions they refer to, and a description of the behaviour measured.

<table>
<tr><th>Test measures in HCA:</th><th>Test:</th><th>Test conditions:</th><th>Behavioural measure description:</th></tr>
<tr><td>am_f_freq_food_sniff_f</td><td rowspan="7">Food withholding test (Test 1)</td><td>familiar</td><td>Number of times cat sniffs covered food</td></tr>
<tr><td>am_f_looks_food_tot_u</td><td>unfamiliar</td><td>Number of looks at food bowl</td></tr>
<tr><td>am_f_walks_away_pers_tot_f</td><td>familiar</td><td>Number of times cat walks away from person</td></tr>
<tr><td>am_f_looks_away_pers_tot_u</td><td>unfamiliar</td><td rowspan="2">Number of times cat looks away from person</td></tr>
<tr><td>am_f_looks_away_pers_tot_f</td><td>familiar</td></tr>
<tr><td>am_f_looks_away_food_tot_u</td><td>unfamiliar</td><td rowspan="2">Number of times cat looks away from food</td></tr>
<tr><td>am_f_looks_away_food_tot_f</td><td>familiar</td></tr>
<tr><td>pm_f_absent_u</td><td rowspan="5">Less food than 'expected' (Test 4)</td><td>unfamiliar</td><td rowspan="2">Duration of time the cat in absent from the test area during the test</td></tr>
<tr><td>pm_f_absent_f</td><td>familiar</td></tr>
<tr><td>pm_f_walks_away_food_tot_u</td><td>unfamiliar</td><td rowspan="2">Number of times cat walks away from food</td></tr>
<tr><td>pm_f_walks_away_food_tot_f</td><td>familiar</td></tr>
<tr><td>pm_f_looks_food_freq_u</td><td>unfamiliar</td><td>Number of looks at food bowl</td></tr>
<tr><td>i_rub_tot_u</td><td rowspan="3">Human-Interaction & play (Test 2)</td><td>unfamiliar</td><td rowspan="2">Number of times a cat rubbed a person</td></tr>
<tr><td>i_rub_tot_f</td><td>familiar</td></tr>
<tr><td>i_sniff_tot_u</td><td>unfamiliar</td><td>Number of times a cat sniffed a person</td></tr>
</table>

i_looks_away_pers_u		unfamiliar	Number of times cat looks away from person
i_walks_away_pers_u		unfamiliar	Number of times cat walks away from person
i_walks_away_pers_f		familiar	
i_freq_look_toy_u		unfamiliar	Number of times cat looks at toy
i_toy_play_lat_f		familiar	Latency of cat to play with toy
em_head_em_lat_u_p	**Emergence (Test 3)**	unfamiliar, passive	Latency of cat to emerge from carrier (head only)
em_head_em_lat_u_a		unfamiliar, active	
em_head_em_lat_f_p		familiar, passive	
em_head_em_lat_f_a		familiar, active	
em_voc_tot_u_p		unfamiliar, passive	Number of vocalisations (“meows”) emitted by cat
em_voc_tot_u_a		unfamiliar, active	
em_voc_tot_f_p		familiar, passive	
em_voc_tot_f_a		familiar, active	
em_app_tot_u_p		unfamiliar,	Number of times a cat approached a person

		passive	
em_app_tot_u_a		unfamiliar, active	
em_app_tot_f_p		familiar, passive	
em_app_tot_f_a		familiar, active	
em_rub_tot_u_p		unfamiliar, passive	Number of times a cat rubbed a person
em_rub_tot_u_a		unfamiliar, active	
em_rub_tot_f_p		familiar, passive	
em_rub_tot_f_a		familiar, active	

Table 2.9. List of individual measures in each cluster from the HCA dendrogram of refined measures (Model #2) (Figure 2.7), their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in physical (p) and/or social contexts (s), and the overall interpretation given for each cluster. Each measure is given in relation to the initial emotional processes and contexts that they were hypothesised to potentially relate to (see Table 2.7), but those capitalised and highlighted in bold are anticipated to be particularly relevant in light of the nature of the clusters as outlined in the table below. For a full description of each test measure, refer to Table 2.8.

Cluster 1 measures:	Emotional processes and context	**Cluster 2 measures:**	Emotional processes and context	**Cluster 3 measures:**	Emotional processes and context	**Cluster 4 measures:**	Emotional processes and context
em_voc_tot_f_p	**R**(**S**/ p)	em_app_tot_u_p	**S**(**P**)	am_f_walks_away_pers_tot_f	**R(S)** f(s)	am_f_looks_away_pers_tot_u	**R(S)** f(s)
em_voc_tot_f_a	**R**(**S**/ p)	em_rub_tot_u_p	**S**(**P**)	i_sniff_tot_u	**S(S**/p**)**	am_f_looks_away_food_tot_u	**R(P)**
em_voc_tot_u_p	**R**(**S**/ p)	em_rub_tot_f_p	**S**(**P**)	i_walks_away_pers_f	**R(S)** f(s)	am_f_looks_food_tot_u	**S(P)**
em_voc_tot_u_a	**R**(**S**/p)			i_rub_tot_f	**S(S**/p**)**	em_app_tot_f_a	**S(**s/**P)**
				i_rub_tot_u	**S(S**/p**)**	em_rub_tot_f_a	**S(**s/**P)**
				i_walks_away_pers_u	**R(S)** f(s)	em_rub_tot_u_a	**S(**s/**P)**
				em_app_tot_f_p	**S(S**/p**)**	am_f_looks_food_tot_f	**S(P)**
				em_app_tot_u_a	**S(S**/p**)**	am_f_looks_away_food_tot_f	**R(P)**
				i_looks_away_pers_u	**R(S)** f(s)	i_freq_look_toy_u	**S(P)**
						am_f_freq_food_sniff_f	**S(P)**
Interpretation of each cluster:							
RAGE:-(primarily a **social** context)		**SEEKING**:- (primarily a **physical** context)		**SEEKING (**RAGE) (primarily **social** context)		**SEEKING** (RAGE) (primarily **physical** context)	

2.3.3 Phase 4 results, refinement and discussion

2.3.3.1 Individual profiles:

In Phase 4, the ‘Cat identity’ (Figure 2.6 (b)) and ‘behavioural measures’ dendrograms (Figure 2.7) (both generated with the same set of refined Phase 3 measures (Model #2)) were used to generate ‘cat group’ and ‘cluster’ profile scores for each individual (Table 2.10). Individual cluster scores for each cat were then studied in relation to the ‘group’ the individual had been assigned to (e.g. Figure 2.6(b)).

All group A cats had relatively low scores for cluster 1 (measures of vocalisations (‘meows’) hypothesised to relate to social RAGE), and high scores for clusters 3 and 4 (measures involving interactions with and disengagement from a person, hypothesised to relate to social and physical SEEKING and the functional management of RAGE). The majority of group A cats also scored between 1-7 for cluster 2 (measures involving the approach and rubbing of passive people, hypothesised to relate to physical SEEKING). These profiles would suggest that Group A cats are potentially those which are keen to explore physical aspects of their environment as well as interact with people. They may also be cats that are able to manage social and physical resource-based frustration well by withdrawing from a situation rather than continually persisting with attempts to access the resource.

In contrast to A, all group B cats had relatively high scores for cluster 1 as well as all scoring 0 for Cluster 2. They also had the lowest four Cluster 3 scores (Table 2.10). These profiles would suggest that Group B cats are potentially more likely to be those that may become frustrated in social situations more easily, have less desire to explore within a novel environment, and are less keen to interact with people.

Table 2.10. Cat profile scores. Collective scores for each cat based on each behaviour cluster (Model #2 'Behavioural measures' dendrogram, clusters 1-4, Figure 2.7). Also indicated is the group the individual belongs to (either A or B (highlighted in grey), based on the 'Cat identity' dendrogram (Figure 2.6 (b)).

Cat identity	Cluster 1 score total	Cluster 2 score total	Cluster 3 score total	Cluster 4 score total	Cat grouping
Beethoven	0	0	54	43	A
Ant	0	1	10	55	A
Bubba	0	1	23	20	A
Bruno	0	1	89	68	A
Angelis	0	5	47	38	A
Allsorts	1	0	80	77	A
Millie	2	0	18	32	A
Becky	2	5	42	34	A
Raymond	4	0	77	61	A
Nelly	4	1	45	90	A
Bramble	7	7	22	65	A
Monty	9	0	4	19	B
Poppy(w3)	10	0	0	8	B
GC	15	0	0	0	B
Rosie	34	0	32	12	A
Poppy(w4)	81	0	1	30	B

2.3.3.2 Linear Discriminant Analysis:

LDA results and measure refinement:

Initial LDA results suggested a high level of accurate prediction in the assigning of cats to the relevant group (either A or B) using the four cluster scores (and data from Model #2) (Table 2.10), with an overall 87% correct prediction rate (See LDA (Model #2), Table 2.11).

Further test refinement:

In order to increase the feasibility of tests for their use in rehoming/adoption environments (by reducing the number of individual tests and measures necessary to perform), further reduction of measures was explored (Models #3-5, Table 2.11).

Because behavioural measures from the Emergence test (Test 3) were the only ones to be represented across all four clusters (see Table 2.9) this test appeared to potentially contain the most informative group of measures. Tests 1 & 2 were thus removed from the test model, and another LDA was performed to assess the effect this removal had upon accurate category prediction (Model #3, Table 2.11).

Overall correct prediction using only Test 3 data remained above 80% and as such, a further reduction in the test model to only Test 3 measures was deemed acceptable. Further removal of individual measures from Test 3 was then explored by performing LDAs on smaller combinations of cluster groups (Models #4 and 5, Table 2.11).

Of the smaller combinations of cluster groups, measures from LDA Model #4 had the higher overall prediction rate. The accuracy of prediction for category B cats was however slightly reduced (from 100% to 75%) compared with LDA Model #2. To assess the potential impact of this reduction upon the nature of how individuals grouped together, another 'Cat identity' dendrogram using LDA Model #4 measures was created (Figure 2.8) and compared with the previous dendrogram (Model #2) (Figure 2.6) containing the fuller set of refined measures.

In both dendrograms, cats were grouped into the same two populations, with the exception of 'Rosie' who moved from group A to group B (Figure 2.8). On inspection of Rosie's profile scores however, her Cluster 1 and 2 values suggested high social RAGE and low physical SEEKING (Table 10.2)) – key features that would also appear to be shared with the other members of group B cats. As such, the relative group change and addition of Rosie to group B was deemed acceptable, and measures from LDA Model #4 (clusters 1-3, Test 3, Table 2.11) were selected based on their ability to feasibly and accurately predict meaningful differences in associations between cats.

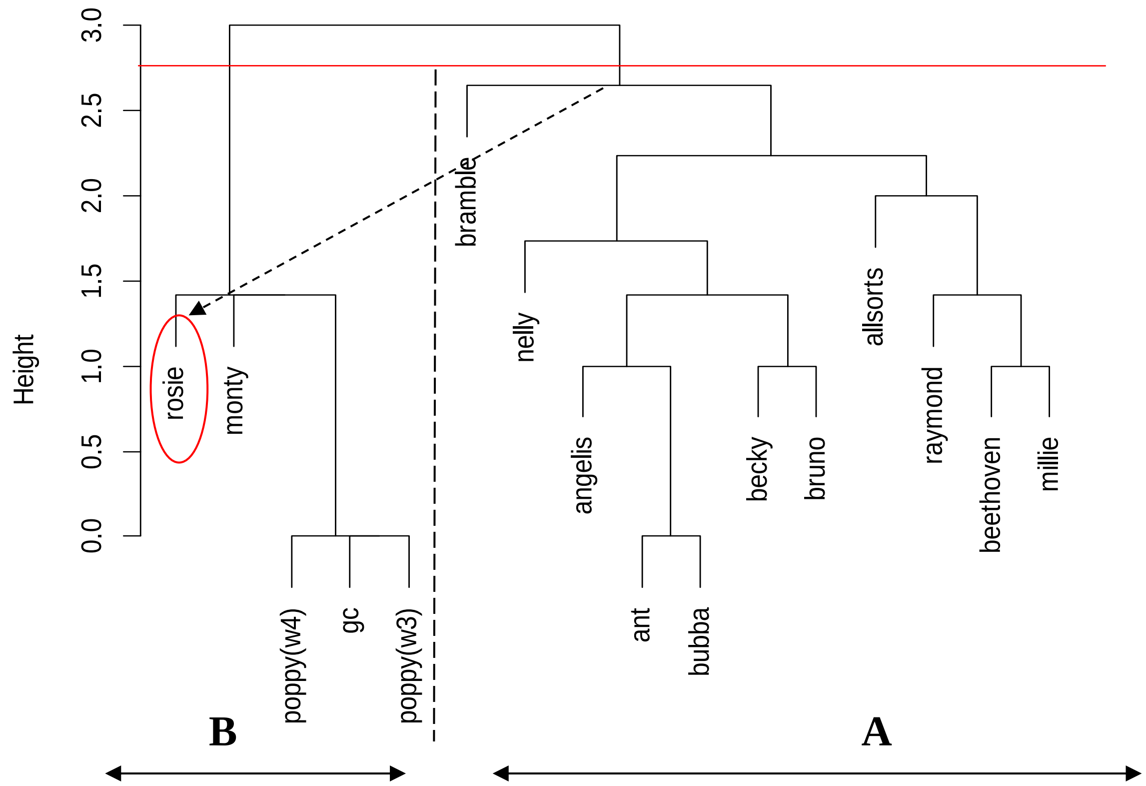

Figure 2.8. Model #4'Cat identity' dendrogram from Hierarchical Cluster Analysis (HCA) performed on behavioural measures from LDA Model #4. Dendrogram of individual cat identity produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from nine individual behavioural measures from Clusters 1-3 of Test 3 data only, across a population of 16 individuals. Two separate groupings of individuals were identified; groups A and B. The dotted arrow denotes the relative change in the position of Rosie from group A to group B (that occurred with the removal of Tests 1 & 2 and Cluster 4 measures). See original 'Cat identity' dendrogram (Figure 2.6 (b)) for comparison.

Table 2.11. Outputs from LDAs performed on Cat profile scores **(n=16)** (Table 2.10) to compare the accuracy of Cat grouping predictions, using data from; Model #2 (Clusters1-4, Tests 1-3) and then Model #3 (Clusters 1-4), Model #4 (Clusters 1-3) and Model #5 (Clusters 1 -2) from Test 3 data only (refer to Table 2.9). Models producing the highest overall category prediction are indicated in bold.

LDA:	**Model #2**	Model #3	**Model #4**	Model #5
Data from Tests used:	**Measures from Tests 1-3**	Measures from Test 3 only	**Measures from Test 3 only**	Measures from Test 3 only
Data from Clusters used:	**Clusters: 1-4**	Clusters: 1-4	**Clusters: 1-3**	Clusters: 1-2
Prior probabilities of groups:	**A = 0.75**	A = 0.75	**A = 0.75**	A = 0.75
	B=0.25	B=0.25	**B=0.25**	B=0.25
Coefficients of linear gradients:	**Cluster 1 = 0.20045761**	Cluster 1 = 0.1489793	**Cluster 1 = 0.1768482**	Cluster 1 = 0.4730404
	Cluster 2 =-0.49177076	Cluster 2 =-0.4653379	**Cluster 2 =0.4297471**	Cluster 2 =0.6003652
	Cluster 3 =-0.44431546	Cluster 3 = -1.5405771	**Cluster 3 =1.2860407**	
	Cluster 4 =-0.08557375	Cluster 4=0.1355247		
Percentage correct for each category (Cat groupings)	**A= 0.8333333** **B= 1.0000000**	A= 0.8333333 B= 0.7500000	**A= 0.9166667** **B= 0.7500000**	A= 0.9166667 B= 0.2500000
Total percentage:	**0.875**	0.8125	**0.875**	0.75

Finally, to assess the effect of the removal of cluster 4 measures on the consistency of the structure or relative 'grouping' of individual test measures, another 'behavioural measures' dendrogram was generated using the measures from Model #4 and then compared with the previous fuller 'behavioural measures' dendrogram (Model #2), from which behavioural clusters were originally identified and interpreted (see Figures 2.7 and 2.9 for comparison).

Across both dendrograms, all of the Model #4 measures maintained the same relative cluster positions to one another (i.e. in both dendrograms measures were located in the same clusters -1,2 &3), thus measures in Model #4 were taken forward as the final test model (see Tables 2.12 & 2.13 for a summary of these measures) and the initial interpretation of clusters 1-3 in relation to underpinning emotional processes were maintained (See Table 2.11).

However, because this refined model no longer contained measures from Tests 1 and 2 that were hypothesised to relate specifically to the 'management' of social RAGE (e.g. am_f_walks_away_pers_tot_f, i_walks_away_pers_f , i_walks_away_pers_u, and i_looks_away_pers_u, refer to Tables 2.7 and 2.9), this aspect was removed from the primary interpretation of this cluster so that Cluster 3 represented (social) SEEKING only (see Table 2.9).

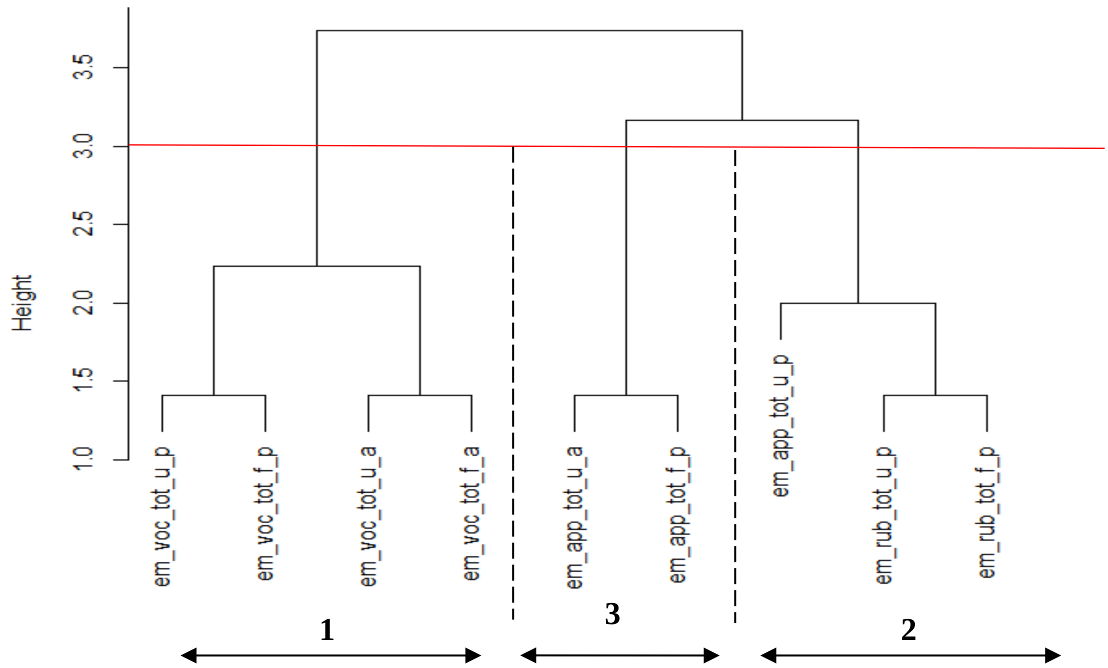

Figure 2.9. Model #4 'Behavioural measures' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on behavioural measures from LDA Model #4. Dendrogram of test measures produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from nine individual behavioural measures across a population of 16 individuals. The central vertical black dotted lines represent the three main clusters that were apparent within the dendrogram (clusters 1,2 &3), whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters.

Table 2.12 List of individual measures in each cluster from Model #4 HCA dendrogram (Figure 2.9), their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) and/or social contexts (s) (refer to Table 2.7), and the overall interpretation given for each cluster. For a full description of each cluster measure, refer to Table 2.8. The relative cluster location of the refined measures is consistent with the location of those in Table 2.9 containing measures from Model #2.

<table>
<tr><th>Cluster 1 measures:</th><th>Emotional processes and context</th><th>Cluster 2 measures:</th><th>Emotional processes and context</th><th>Cluster 3 measures:</th><th>Emotional processes and context</th></tr>
<tr><td>em_voc_tot_f_p</td><td>R(s)</td><td>em_rub_tot_u_p</td><td>S(p)</td><td>em_app_tot_f_p</td><td>S(s)</td></tr>
<tr><td>em_voc_tot_f_a</td><td>R(s)</td><td>em_rub_tot_f_p</td><td>S(p)</td><td rowspan="3">em_app_tot_u_a</td><td rowspan="3">S(s)</td></tr>
<tr><td>em_voc_tot_u_p</td><td>R(s)</td><td rowspan="2">em_app_tot_u_p</td><td rowspan="2">S(p)</td></tr>
<tr><td>em_voc_tot_u_a</td><td>R(s)</td></tr>
<tr><td colspan="6">Interpretation of each cluster:</td></tr>
<tr><td colspan="2">RAGE:-(primarily a social context)</td><td colspan="2">SEEKING:- (primarily a physical context)</td><td colspan="2">SEEKING (primarily social context)</td></tr>
</table>

Table 2.13 Plain summary of the refined model (Model #4) of behavioural tests measures

Behaviour measure	**Test condition**	
	Person	**Interaction style**
Total rubs on person	unfamiliar	passive
	familiar	passive
Total approaches (ending in contact)	unfamiliar	passive
	familiar	passive
	unfamiliar	active
Total vocalisations (meows)	familiar	passive
	familiar	active
	unfamiliar	passive
	unfamiliar	active

2.4 Discussion:

2.4.1 Summary of Experiment 1:

Four separate experimental test scenarios involving specific physical and social contexts that were hypothesised to induce FEAR, RAGE and SEEKING were developed. A large collection of individual behavioural measures across these tests were identified and assessed for their reliability across social and short-term temporal gradients. Whilst various measures were identified as being relatively consistent, many were significantly variable, with some being influenced by social and temporal factors in relatively complex ways. Such results would suggest that these behavioural measures are the least reliable for use in the identification and assessment of meaningful individual differences and underlying 'traits' in cats in experimental or test contexts.

Following the exclusion of measures during the reliability and refinement process, nine individual behavioural measures were retained. These were taken from one specific test scenario (Test 3); from three main behavioural responses (vocalisations (“meows”), rubs and approaches a person ending in physical contact) (See Table 2.12) across the various different social conditions (i.e. unfamiliar passive, unfamiliar active, familiar passive and familiar active person). Whilst this process of measure reduction substantially impacted upon the amount of individual measures used, the information generated in relation to the specific traits of interest remained relatively consistent.

The use of only Test 3 measures reduces the amount of necessary testing substantially and as a result greatly increases the future practical application of the behavioural tests. From both a practical and experimental perspective, Test 3 was also the test most easily executed without compromising the day to day running of the rehoming centre, as well as being the easiest experimental condition to control and standardise. This was primarily due to its location – away from rehoming staff and the general public, so that sporadic acoustic and visual disturbance was minimal (something that was more difficult to control in Tests 1, 2 & 4).

2.4.2 Relevance of the general findings in relation to other research:

The apparent variability of many of the behavioural responses of cats towards people identified within Experiment 1 may have important implications in regards to the reliability of other behaviour/temperament tests that have been developed for use in domestic cats (e.g. Lee *et al* 1983, Siegford *et al* 2003, Slater *et al* 2013 a&c).

The results of Experiment 1 indicated that whilst certain behavioural responses were consistently reliable across temporal and social gradients in several different tests (e.g. Number of times a cat walked away from a person was reliable in both Test 1 and also Test 2), this was not the case for all measures (e.g. Number of times a cat rubbed a person was reliable in Test 2 but not in Test 4, see Tables 2.5 & 2.6)). Within the same test context, many behavioural responses were also significantly influenced by the social factors of a person such as their interaction style (e.g. Latency and frequency to approach and rub people in Test 3).

Such results would suggest that where tests are developed within a single context without the environmental/context stability of specific behavioural responses being assessed (e.g. Slater *et al* 2013), and either do not (e.g. Siegford *et al* 2003 (Open Field Test)) or give only basic instruction in regards to how the test person should interact with a cat during the test (e.g. Lee *et al* 1983, Siegford *et al* 2003 (Feline Temperament Test), it cannot be assumed that such tests are reliable for use in other physical environments, or are robust enough to account for potential variations in interaction or handling styles of the people that may occur during a test. As such the robustness of their general validity is questionable.

2.4.3 Significance of the test results in relation to the prediction of human sociability and 'rehomeability':

From the refined set of measures carried forward to Phase 3, four clusters of behaviour measures were identified and interpreted in relation to their hypothesised underpinning emotional components. Using the measures located within these clusters, two separate groups of cats with distinctive behavioural profiles were identified in a small test sample (the 16 individuals). Group A cats scored low for measures predicted to relate to social RAGE, but highly for measures relating to social and physical aspects of SEEKING, and the functional management of RAGE. Group A cats are therefore predicted to be those that may integrate relatively well within new social and physical situations, may be more likely to perceive humans as a positive interactive resource, as well as manage their frustration more effectively.

The smaller population of cats in group B scored higher for clusters potentially indicative of social RAGE, and lower for measures indicative of physical and social SEEKING. As such, group B cats could represent the more 'problematic' cat population that may be more difficult to socially integrate with people, and would find living in a domestic environment with humans difficult. It is hypothesised that these types of cats may take much longer to habituate and adapt to new environments and as a consequence find environmental changes stressful. They may be less keen to interact socially with people and could potentially behave aggressively when attempts to interact with and handle them are made. This has substantial practical relevance.

A survey of rehoming centres indicated that aggression towards people featured highly amongst the behavioural reasons given for relinquishing a pet cat (Salman *et al* 2000), and in a retrospective study within an animal behavioural clinic, aggression towards people was one of the most common behavioural problems cited by owners (Amat *et al* 2009). Such evidence would suggest that these types of behavioural responses towards humans are perceived as substantial issues that may not be tolerated well by certain owners. Additionally, one study found that when initially selecting a cat from a rehoming centre, adopters preferred less 'stressed' cats (or those more adapted to their current surroundings) as well as those that seemed 'happy' and 'friendly' (Gourkow and Fraser 2006). Such findings would suggest that cats that are less well adapted and less keen to interact with people are also less desirable. Lastly, from a welfare perspective, the manifestation of the above types of behavioural issues within the home (such as might be predicted for type B cats) could also be an indication of compromised physical and emotional health (Rochlitz 2000, Heath 2007). Thus in comparison to Group A, it is hypothesised that Group B cats may be those that take longer to rehome from a rehoming centre, are more likely to be returned due to owner dissatisfaction, and could be of a greater welfare concern.

2.4.4 Limitations of current test model and the next phase of measure development:

During this initial stage of measure development, a series of potentially reliable behavioural measures were identified, their relevance to underlying traits of interest (face validity) assessed and their necessity evaluated to create a refined 'test model'.

However, because these tests were developed at a single rehoming centre on a relatively small population of cats, at this point, their reliability cannot be assumed nor results generalised to larger cat populations across different external locations, without further testing.

Due to the additional social factor that was included in Test 3, (the interaction style of the person), each day of testing comprised of a different combination of social factors (i.e. passive and active interaction styles with familiar and unfamiliar people), and as such the consistency (or reliability) of these measures under the same specific social conditions across repeated testing could not be assessed. Because temporal as well as environmental consistency of behaviour is important to determine in the development of reliable indicators of underlying traits (see Dingemanse *et al* 2002, Réale *et al* 2007; Sih and Bell 2008, Stamps and Groothuis 2010), the temporal stability of these measures must be assessed.

Additionally, the battery of tests initially developed during Experiment 1 was carried out in a specific sequence, however during the test refinement process detailed within this chapter, three of the four initial test contexts were removed (e.g. Food withholding (Test 1), Human interaction and play (Test 2) and Less food than 'expected' (Test 4)). As such it is necessary to assess the remaining measures for their reliability in the absence of these potential test-sequence effects.

Lastly, it is also important that the reliability of refined measures are assessed under conditions where the test order effects of the different social factors (i.e. active/passive, familiar/unfamiliar) within the remaining test context (Emergence test (Test 3)), are controlled for, so that true test effects can be identified in the absence of potential social-condition order confounds.

This is an important stage in the development process of an assessment tool that enables the robustness of measures to be assessed in the face of multiple different combinations of preceding test conditions.

Therefore, the aims of the next phase of measure development are to:

i) Apply the test model on a large population;

ii) With a counter-balanced test order design;

iii) Across multiple different rehoming centres;

iv) With a sub-population of cats across each centre that are re-tested in each test condition.

2.5 Conclusion:

This chapter has shown that a series of initial behavioural tests, hypothesised to relate to several core emotional processes predicted to be important in the relative 'rehomeability' of cats, can be executed practically within a rehoming environment, assessed for their reliability and subsequently refined. Results of the initial reliability analyses performed indicated significant temporal and social interactive effects on many behavioural responses extracted from tests. These results have important implications for accepting the robustness of behavioural tests where their reliability has not been assessed in such a way.

2.5.1 Main findings and questions raised:

- The main findings within this chapter highlight the difficulties associated with developing non-invasive and practical tests to assess behavioural tendencies relevant to human-sociability in cats within the rehoming environment.
- The inconsistency of many of the measures analysed suggest an inerrant amount of intra-individual variability in behaviour, thus the amount of measures remaining within the final test model is limited, reducing its overall content validity.
- Such findings raise the question of whether these types of behavioural measures taken in standardised test situations represent useful methods of temperament assessment. However a potentially useful model *was* identified and its utility should be further explored before such behavioural models are discarded.

3 Chapter 3 - Experiment 2: Assessing the reliability of refined behavioural measures

3.1 Introduction:

The refined set of test measures developed in Experiment 1 were taken forward and assessed for their reliability during a second study (Experiment 2).

3.1.1 Chapter aims:

The aims of Experiment 2 were to assess the longer-term temporal consistency as well as environment/location stability of behavioural measures on a large population, where test order effects are controlled for, in order to determine the general robustness of the proposed test model for use across the general rehoming sector.

3.2 Methods:

3.2.1 Test Population:

An initial population of 131 cats across three different UK rehoming centres (61 cats from Battersea Dogs and Cats Home (BDCH); 50 from Wood Green, The Animals Charity (WG), and 20 from The Mayhew Animal Home (MHW)) were tested. Ages of cats ranged from six months to 16 years; with an average age of 4.6 years, comprising of 45 male and 86 female cats. All cats were non-pedigree domestic breeds, of which 121 were short-haired and ten were either long or semi long-haired. 127 of the cats were neutered, one female cat was unneutered, and the neuter status of three females was unknown. All cats were housed in discrete units individually, or with a familiar conspecific they had lived with in a previous home.

Units were typically rectangular is shape with an approximate total floor space of 1-1.5 x 2.5-3.5m, with additional space provided via raised areas or shelving within the unit. Each unit also contained at least one of each of the following; scratching post, soft bed area, litter tray, toys, and a concealed 'hiding' place (such as a 'cat igloo' or cardboard box). At two sites (MHW and WG) units contained a smaller raised compartment within the main structure. Staff: unit ratios were generally similar across the three sites, ranging from approximately 1:12 (MHW and WG) to 1:14 (BDCH), but are likely to have varied slightly each week depending upon staffing, rehoming and intake activity, and were not specifically measured due to practical limitations. Cats across all sites received regular social interaction and play with either a staff member or volunteer, however no centres had formal socialisation protocols, and as such the nature of the social interactions with cats at each site may have varied. Cats at WG had additional (time shared) access to an enclosed 'run' whilst at the other two sites cats only had access to their individual unit. All cats had constant access to fresh water, and were usually fed dry kibble ad-libitum and wet food 2-3 times per day (depending upon dietary requirements).

The inclusion criterion for test cats was as outlined in Experiment 1. All cats had been housed within the rehoming centre for a minimum of seven days, and at the time of testing, the majority of cats had been within the centre for less than fourteen days). A total of 21 cats were not able to be tested on at least one day over the four day study period due to handling issues and thus could not be safely and calmly placed in the carrier (for example they attempted to bite or swipe the handler with claws unsheathed). Additionally, one cat was rehomed during the study, two were missed from one condition due to time limitations and six were removed due to health reasons (e.g. for a rescheduled veterinary procedure, suspected flu symptoms etc.). Thus the total population that received the full battery of tests consisted of 101 cats (48 from BDCH, 35 from WG and 18 from MHW), with the remaining 31 cats receiving between 0 and three of the test conditions.

3.2.2 Test environments:

In each centre, cats were tested in a novel room that was quiet and free from any visual or olfactory presence of other cats. The size of the test rooms varied between centres but in each case provided enough space for the test corridor (see Figure 2.4, Chapter 2), as well as areas outside of this with places for the cat to hide and walk about if they chose. Windows within the test areas were covered to control for external visual disturbance. If the test room was large enough it was divided into two parts and cats were tested alternately in each part over the four day period. If the room was too small to divide, the position of the hatch and features (such as chairs or tables etc.) within the room were rearranged so that the room retained an element of novelty each day.

3.2.3 Behavioural tests:

Cats were exposed to the refined test conditions used in Experiment 1 (all originating from the Emergence Test, Test 3, see Table 2.12, Chapter 2), over a consecutive four day period. Test protocols were as outlined in Chapter 2, but this time with a randomised test order presentation between cats (see Table 3.1).

3.2.4 Test order assignment:

Cats were pseudo-randomly assigned a specific test order from one of the 24 different possible combinations (see Table 3.1) depending upon which days their ‘familiar person’ (member of cattery staff) was available. Across all centres, cats were tested as equally as possible across the 24 combinations.

Table 3.1 All combinations of test conditions. u= unfamiliar person, f= familiar person, p=passive interaction style of person and a= active interaction style of person.

Test day 1	**Test day 2**	**Test day 3**	**Test day 4**
up	fa	ua	fp
fa	ua	up	fp
fp	up	fa	ua
ua	fp	up	up
up	ua	fp	fa
fp	ua	fa	up
fp	up	ua	fa
ua	fa	up	fp
up	up	fp	ua
fa	fp	ua	up
ua	up	fp	fa
up	fa	fp	ua
fa	fp	ua	up
up	ua	up	fp
fp	up	fa	ua
fa	fp	up	ua
ua	fp	fa	up
up	ua	fp	fa
fp	up	ua	up
ua	fa	up	fp
ua	fa	up	fp
up	ua	fa	fp
fa	up	fp	ua
up	fp	ua	up
fp	ua	up	fa

3.2.5 Test-retest:

The Emergence test protocol was repeated on a sub-population of 12 cats (eight individuals from BDCH and four from WG). Due to practical limitations, no cats from MHW were re-tested. Cats were re-tested opportunistically approximately two to three weeks from day one of their first test, depending upon whether they were still residing at the centre or not. Whether cats remained long enough to be re-tested depended upon a number of different factors such as whether interest in a cat (from a person deemed suitable) had been shown, as well as if the cat had any pending minor surgery (such as dental work, neutering or second vaccinations etc.) before they were eligible for rehoming. As such, the re-test population contained both cats that potentially (for behavioural or physical reasons) were still unreserved, as well as those that were reserved but still waiting to go home. Of the 12 re-tested cats, six had at least one test condition missing from either their first or second test batch (four because handling had to be paused due to the behavioural response of the cat, one for health reasons and the other due to adoption).

3.2.6 Data analysis:

The video footage collected was then coded for the refined behavioural measures (see Table 3.2), but across all four test conditions and their combinations (i.e. familiar, unfamiliar, active, passive) so that the general stability (consistency of relationship between test condition and behaviour) across each centre could be assessed. All coding was carried out using the software package *Noldus* Observer 10.5.

3.2.6.1 Statistical methods:

All analyses were carried out in R software (version 3.1.0) (R Development Core Team, 2014).

3.2.6.1.1 Initial structural stability of behavioural measures:

The stability of the structure of the refined test measures carried forward from Experiment 1 (see Figure 2.9 and Table 2.12, Chapter 2) was first assessed. This was an important initial step in the determining of measure robustness; ensuring measures were consistent in their representation of the hypothesised underpinning emotional processes of interest across both the initial small and much larger population of cats. This process was initially performed using the full test model (Model #4, Table 2.12, Chapter 2) for both populations and was carried out prior to any further measure reduction that occurred during subsequent analyses in Experiment 2.

A Hierarchical Cluster Analyses (HCA) with Euclidian distancing was performed on the refined measures from Experiment 2 data. A dendrogram of the HCA was then generated using the *hclust* function from the *stats* package (R Core Team 2013) and compared with the equivalent Experiment 1 dendrogram (Figure 2.9) to assess the relative consistency of measure clusters between the two dendrograms. For both HCAs, the data used to generate the dendrograms was in a binary format (based on whether a behaviour had or had not occurred).

3.2.6.1.2 Inter-observer reliability of coding:

Ten percent (40 videos) of Experiment 2 footage were analysed for inter-observer reliability (two observers analysing five percent of the footage each). Every tenth video from a randomised list of video files was selected for recoding, so that a range of cats across all test conditions were represented. To assess inter-observer reliability, data from the two observers was pooled and then compared with the original coded values by extracting the Intra Class Correlation Coefficients (ICC) ('a measure of absolute agreement which is sensitive to the differences in means between observers' (Revelle 2014, *taken from* Shrout and Fleiss (1979)) for each behaviour measure.

ICC's were calculated using the *ICC* command from the *psych* package (Revelle 2014). For each ICC test, alpha was set at 0.5.

3.2.6.1.3 Intra-individual/longitudinal reliability of behaviour:

Using data from the test-re-test population of cats, each behavioural measure from the refined test conditions outlined in Table 2.12 (Chapter 2) was assessed for repeatability (the 'proportion of between-individual variance relative to the total phenotypic variance' (Nakagawa and Schielzeth 2010)), across a time interval (between two to four weeks). Because several cats had missing conditions from either their first or second test batch, the sample size available for each measure analysed ranged from six to nine individuals.

The *rptR* package was used to calculate GLMM Poisson (with multiplicative overdispersion) based reliability estimates (Nakagawa and Schielzeth 2010). Again models were assessed for overdispersion. The linked and original scale repeatability estimates were compared (Solomon & Taylor 1999) and in each case were not substantially different from one another, thus the original scale estimates were reported.

3.2.6.1.4 HCA and Interpretation of remaining reliable behavioural measures:

Following the above process, unrepeatable measures were then removed from the test model, and the effect of their removal was assessed by performing another HCA dendrogram using only the reliable measures, and comparing this to the previous dendrogram (see Figures 3.1 & 3.2).

3.2.6.1.5 Environmental stability of measures:

Each behaviour measure was analysed separately to test for the effects of the familiarity of a person, their interaction style, the rehoming centre and their interactions, on the responses of cats. Effects were analysed using Generalised linear mixed models (GLMMs) with Poisson error structures. Individual identity of the cat was treated as a random fixed effect within the models. Only data from cats that received the full battery of tests (i.e. were tested in all of the conditions) (n=101) were included in the analysis.

The package *lme4* (Bates 2007) was used for the mixed effects models. Models were simplified using maximum likelihood fits, by the process of step-wise elimination of the least significant effects to produce Minimum Adequate Models (MAMs) (Crawley 2007). Model diagnostics were performed to assess normality, heteroscedasticity and check for overdispersion.

3.3 Results:

3.3.1 Structural stability of behavioural measures:

A HCA dendrogram based on the refined behavioural test measures using data from Experiment 2 was ‘cut’ horizontally at a point where several distinct clusters of measures could be identified (Figure 3.1). This was then compared with the Model #4 dendrogram from Experiment 1 (Figure 2.9, Chapter 2). Across both dendrograms, three main clusters of measures were identified, and apart from one specific measure (‘em_app_tot_up’) which changed location from cluster 3 to cluster 2 (Figure 3.1) the contents of these clusters remained consistent across the two data populations (Exp. 1 and 2).

The relative consistency of the structure of measures was therefore considered acceptable, and the previous interpretation of clusters 1-3 in terms of their relation to underpinning emotional processes was maintained (See Table 3.2).

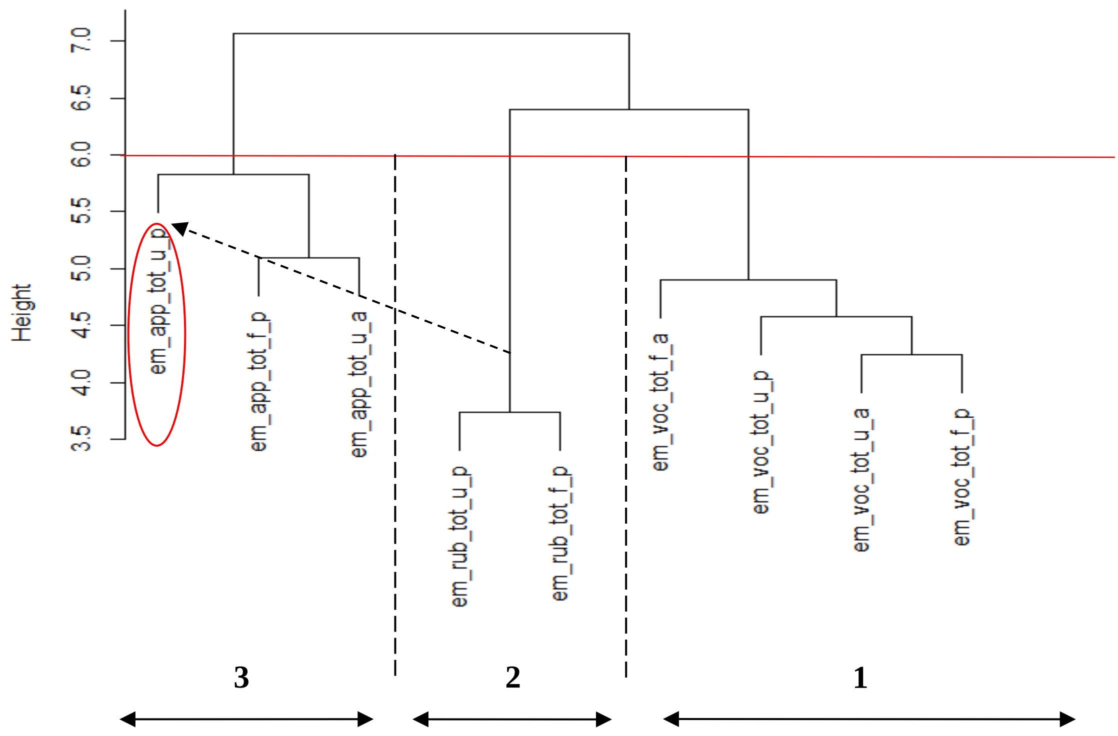

Figure 3.1. Model #4 'Behavioural measures' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on refined measures carried forwards from Experiment 1, using data gathered during Experiment 2. Refer to Table 2.8, Chapter 2 for full description of each test measure. Dendrogram of test measures produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from nine individual behavioural measures across a population of 101 individuals. The central vertical black dotted lines represent the three main clusters that are apparent within the dendrogram (clusters 1,2 &3), whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters. The dotted arrow indicates the relative change in position of the measure circled in red ('em_app_tot_u_p') from its original position (in Figure 2.9, Chapter 2) to its current location.

Table 3.2. List of individual measures in each cluster from Model #4 HCA dendrogram (Figure 3.1), performed on data from Experiment 2, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. For a full description of each measure within a cluster, refer to Table 2.8 in Chapter 2.

Cluster 1 measures:	Emotional processes and context	**Cluster 2 measures:**	Emotional processes and context	**Cluster 3 measures:**	Emotional processes and context
em_voc_tot_f_p	R(s)	em_rub_tot_u_p	S(p)	em_app_tot_f_p	S(s)
em_voc_tot_f_a	R(s)	em_rub_tot_f_p	S(p)	em_app_tot_u_a	S(s)
em_voc_tot_u_p	R(s)			em_app_tot_u_p	S(s)
em_voc_tot_u_a	R(s)				
Interpretation of each cluster:					
RAGE:-(primarily in a **social** context)		**SEEKING**:- (primarily a **physical** context)		**SEEKING** (primarily in a **social** context)	

3.3.2 Inter-observer reliability:

Intra-class correlations for each behavioural measure were high and significant (all ≥0.9, p<0.001, see Table 3.2), suggesting a good level of Inter-observer reliability of coding across the various test conditions.

Table 3.3 ICC statistics for inter-rater reliability coding. Based on the experimental design, ICC*1k* values ('a measure of absolute agreement which is sensitive to the differences in means between observers' (Revelle 2014, *taken from* Shrout and Fleiss (1979)) are reported.

Behavioural measure:	Intraclass Correlation Coefficient (ICC1k):	F value:	Degrees of freedom:	P value:	Confidence Intervals - Lower bound, upper bound
Total meows	0.99	159	39,40	<0.0001***	0.99,1.00
Total approaches	0.90	10	39,40	<0.0001***	0.82,0.95
Total rubs on person	0.97	33	39,40	<0.0001***	0.94,0.98

3.3.3 Intra-individual/longitudinal reliability of measures:

Just over 50% of the measures from the individual test conditions analysed were significantly repeatable within the same test-retest population.

Frequency of meows were significantly repeatable ($p<0.05$) for all conditions apart from fp (familiar person, passive interaction style), whilst frequency of approaches were significantly repeatable for both of the passive conditions (up and fp both $p<0.05$), but not for the active condition (ua) tested. Neither of the test conditions in which frequency of rubs were assessed was significantly repeatable, meaning no measures from Cluster 2 ((physical) SEEKING) were sufficiently high in intra-individual reliability (Table 3.4).

Table 3.4 Summary of reliability statistics (the 'proportion of between-individual variance relative to the total phenotypic variance' (Nakawagawa and Schielzeth 2010)) performed on the test-retest population of cats in Experiment 2 (*n= 12*). Intra-individual reliability of the refined measures assessed using GLMM for Poisson data (with multiplicative overdispersion) based repeatability estimates. Estimates are given on the original scale and significant results are highlighted in bold. For each behaviour test condition, population size and composition are also reported.

Behaviour measure and population size	Test condition	Population composition	Repeatability score	P value	Cluster location
approach (n=7)	UP	BDCH N=4 WG N=3	**R= 0.732**	**P= 0.03***	**3**
approach (n=9)	UA	BDCH N=7 WG N=2	R= 0	P= 0.926	3
approach (n=9)	FP	BDCH N=6 WG N=3	**R= 0.828**	**P= 0.008***	**3**
rub (n=6)	UP	BDCH N=4 WG N=2	R= 0	P= 0.603	2
rub (n=7)	FP	BDCH N=6 WG N=1	R= 0	P= 0.151	2
meow (n=7)	UP	BDCH N=5 WG N=2	**R= 0.957**	**P= 0.019***	**1**
meow (n=9)	UA	BDCH N=7 WG N=2	**R= 0.798**	**P= 0.011***	**1**
meow (n=9)	FP	BDCH N=7 WG N=2	R= 0	P= 0.291	1
meow (n=9)	FA	BDCH N=7 WG N=2	**R= 0.855**	**P= 0.045***	**1**

.

3.3.4 HCA and interpretation of reliable behavioural measures:

A HCA dendrogram based only on the suitably reliable behavioural test measures (Model #6) identified above (see Table 3.4) was ‘cut’ horizontally at a point where two distinct clusters of measures could be identified. This was then compared with the previous Model #4 dendrogram (Figure 3.1). Although all of Cluster 2 measures (e.g. physical SEEKING) and one measure from Cluster 1 (e.g. social RAGE) and Cluster 3 (e.g. social SEEKING) were omitted from Model #6, Clusters 1 and 3 were still readily identifiable (refer to Figure 3.1 and Figure 3.2, see also Table 3.2 and 3.6 to compare between Models #4 & #6). However, because Cluster 3 no longer contained measures from the active test conditions (only passive), the labelling of the cluster was refined to be more specific and as such the addition of a potential *physical* context of SEEKING was inserted for the interpretation of this cluster.

Both clusters were renamed to reflect their contents; Cluster 1 to sRB (representing social RAGE behaviour measures) and Cluster 3 to s/pSB (representing social and/or physical SEEKING behaviour measures).

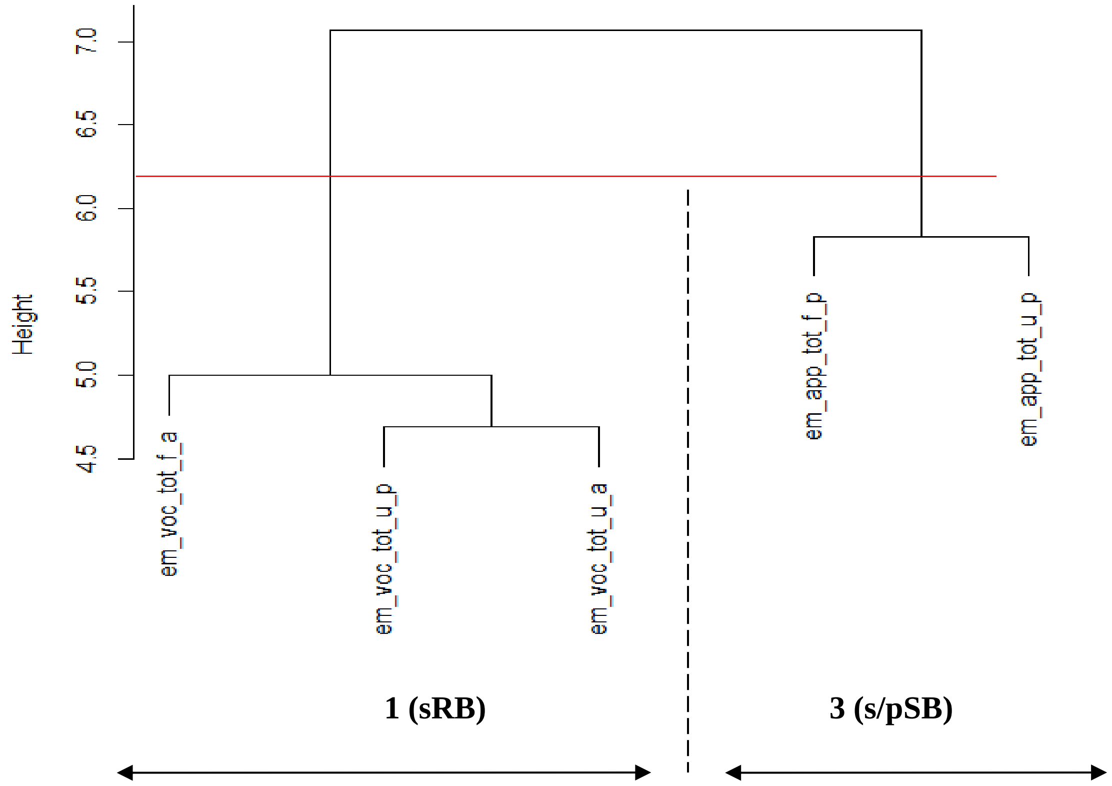

Figure 3.2 Model #6'Behavioural measures' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on only the longitudinally reliable measures from Model #4, using data gathered during Experiment 2. Dendrogram of test measures produced using average linkage between groups based on binary squared Euclidean distance matrix. Data taken from five individual behavioural measures across a population of 101 individuals. The central vertical black dotted lines represent the two main clusters (1&3) that are apparent within the dendrogram, whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters.

3.3.5 Environmental stability of measures:

Approaches:

The frequency of approaches ending in contact was the most consistent measure across the three different locations. This behaviour was not significantly affected by the individual centre, nor by the familiarity of the person, only by their interaction style, ($p<0.0001$); with passive people being approached significantly less often ($p<0.0001$) (refer to Table 3.5).

Vocalisations:

Frequency of vocalisations (meows) was the least consistent measure across the different locations; at BDCH cats meowed significantly more in the presence of passive people ($p<0.05$), but familiarity had no effect. At MHW cats meowed significantly more in the presence of unfamiliar passive people ($p<0.0001$), but at WG the inverse of this relationship was true – cats meowed significantly *less* in the presence of unfamiliar passive people ($p<0.0001$) (refer to Table 3.5).

Table 3.5 Significant effects from all refined behavioural test measures; the factors found to have a significant effect upon them (either as a single factor or as a two or three-way interaction, denoted by the presence of an ‘x’ in the relevant column). Statistical results taken from GLMM X^2 tests, using stepwise elimination of non-significant factors. Test statistics for factors retained within the Minimum Adequate Models (MAM's) only are reported. For the ‘direction of effects’, test statistics are taken from summary outputs of the Minimum Adequate Models (MAM's).

Population size and origin	**Test measure**	**Familiarity: Interaction style: Centre**	**Centre: Interaction style**	**Centre: Familiarity**	**Familiarity: Interaction style**	**Centre**	**Familiarity**	**Interaction style**	**Statistical effects found**	**Direction of effects**
All centres (n=101)	Approach	no effect	no effect	no effect	no effect	no effect	no effect	**X**	interaction style (X^2= 421.69, df=0, p<0.0001***)	**Passive** people were approached **significantly less** (Estimate= -0.61218, SE= 0.09085, Z = -6.739, p<0.0001***)
All centres (n=101)	Meow	**X**	NA	NA	NA	NA	NA	NA	familiarity: interaction style: centre X^2= 44.522 , df=2, p<0.0001***	See below for individual centre-specific effects

BDCH (n=48)	Meow	NA	NA	NA	no effect	NA	**X**	no effect	familiarity X^2= 512.96, df=0, p<=0.02783 *	Cats meowed **significantly more** in the presence of **passive people** (Estimate=0.3965,SE= 0.1093, Z=3.626, p<0.0001***)
MHW (n=18)	Meow	NA	NA	NA	**X**	NA	NA	NA	familiarity: interaction X^2=31.688, df=1, p<0.0001***	Cats meowed **significantly more** in the presence of **unfamiliar passive** people (Estimate=1.115836, SE=0.001418, Z=787.0 p<0.0001***)
WG (n=35)	Meow	NA	NA	NA	**X**	NA	NA	NA	familiarity: interaction style X^2= 19.896, df=1, p<0.0001***	Cats meowed **significantly less** in the presence of **unfamiliar passive** people (Estimate=-0.520515, SE=0.001005, Z= -518.0, p<0.0001***)

Table 3.6 List of individual measures in each cluster from the HCA dendrogram of refined longitudinally reliable measures (Model #6) (based on the results of Table 3.4) their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster sRB contained behavioural measures that represent social RAGE, whilst cluster s/pSB social and/or physical SEEKING. For a full description of each cluster measure, refer to Table 2.8 in Chapter 2.

<table>
<tr><th>Cluster sRB:</th><th>Emotional processes and context</th><th>Cluster s/pSB:</th><th>Emotional processes and context</th></tr>
<tr><td rowspan="2">em_voc_tot_f_a</td><td rowspan="2">R(s)</td><td>em_app_tot_f_p</td><td>S(s/p)</td></tr>
<tr><td rowspan="3">em_app_tot_u_p</td><td rowspan="3">S(s/p)</td></tr>
<tr><td>em_voc_tot_u_p</td><td>R(s)</td></tr>
<tr><td>em_voc_tot_u_a</td><td>R(s)</td></tr>
<tr><td colspan="4">Interpretation of each cluster:</td></tr>
<tr><td colspan="2">RAGE:-(primarily a social context)</td><td colspan="2">SEEKING (in a social and/or physical context)</td></tr>
</table>

3.4 Discussion

3.4.1 Overview of Experiment 2 results:

Initial comparisons of the structure of the measures within the retained test model between Experiment 1 and Experiment 2 were made, and results suggested a good level of internal consistency (and thus general model robustness) across the two populations.

During the next phase, the quality of individual measures from this test model was further assessed by determining their reliability at an individual level over time and at a group level between different practical locations. Of the nine refined behavioural measures that were assessed for their temporal stability, only five were found to be significantly reliable, although it is important to note that the test-retest sample sizes were relatively small (data were collected from only two of the three centres, the majority of which were from BDCH) and as such their generalisation to the population as a whole may be limited.

Across the three rehoming centre locations, the frequency of ‘approaches’ was the most consistent measure, affected by social factors in a similar way across centres, whilst frequency of ‘meows’ were affected differently by social factors depending upon location. Therefore, where such measures are used in further analysis, it is important that they are done so with consideration of the effect of centre location.

Approaches:

Frequencies of approaches were significantly repeatable over time for both of the Passive (up and fp), but not the active (ua) conditions assessed. At each location, the same relationship with social factors was found, suggesting that under certain conditions, this behaviour has elements of both temporal and environmental stability (Stamps and Groothuis 2010).

Across locations, the behaviour of the person, but not their familiarity had a significant effect on frequency of approaches, with cats approaching passive people less often. Whilst these results would seem to contradict those of Mertens and Turner (1988) who found that mean approaches of passive people were *higher* than for active people, there was much individual variability between cats, and the active condition in their study was quite different from the one in the present experiment. In their study, people were able to move around freely and interact with the cat as they wished, which may have meant either that the cat did not need to approach the person to initiate contact, (because the person approached the cat), or that this type of interaction was aversive for some cats that were not able to effectively control the amount of interaction they received, causing several individuals to ‘withdraw constantly from the person’ (Mertens and Turner 1988). Indeed other studies would suggest that interactions initiated by the cat last longer (Turner 1990) and include more time spent in close proximity with the person (Mertens 1991), than when interactions are initiated by the person.

Meows:

Ap**a**rt from within the fp condition, frequencies of meows were significantly repeatable over time for each of the different social conditions, however assessment of the stability of these behaviours across different physical locations suggested interesting location: social factor interactions. Whilst two centres indicated a trend for cats to meow more when in the passive interaction conditions (BDCH and MHW), (a trend also noted by Mertens and Turner 1998) this was not the case for WG, where the inverse relationship was indicated (cats meowed *less*). At BDCH the familiarity of the person had no significant effect on the frequency of meows, but this was not consistent at the other two centres, where meows were differentially affected by the interaction of familiarity and interaction style (at MHW cats meowed *more* in the up condition and at WG cats meowed *less* in the same condition).

Environment-specific social effects:

What the above results may suggest is that whilst (at the level of the individual) such vocal behaviours appear consistent in the way they are affected by the social context, the nature of this relationship is a function of the specific environment the cat resides within. It is possible that in different situations, the same type of behaviour may serve different social functions and/or relate to different types of affect, perhaps in part due to the differing relationships cats may form with people within/between different rehoming centres, as a consequence of how they are managed/interacted with.

For example, Yeon *et al* (2011) indicated that both social experience and current external environment may affect the qualities of meows emitted by cats, and research by Nicastro and Owren (2003) found that meows taken from ‘agonistic’ encounters with humans were significantly higher in duration and lower in frequency than those taken in interactive contexts associated with more positive valence. Similar results to these were also found in a more recent study by Schötz and van de Weijer (2014).

In regards to another type of vocalisation (the purr), context has again been suggested as having a significant effect on the nature of vocalisations emitted by the cat, with different frequencies of purrs being associated with different situations as well as different levels of perceived 'urgency' by humans. Higher frequencies of purrs were interpreted as serving a specific 'care soliciting' function during attempted food acquisition (McComb 2009).

Another explanation for location specific effects on behaviour could be that the behavioural profiles of the three different populations were somehow different. To check for this, a HCA was performed using behaviour scores taken from each individual, identified by their location (see appendix 3.1). However the resulting groupings of individuals did not indicate any location-skew in their distribution and it is therefore assumed that the above effects are indicative of different motivational/functional and/or affective states or predispositions when being tested rather than the existence of location-specific behavioural profiles.

Whilst test protocols and social conditions were standardised across locations, it is possible that 'familiar' people were not always perceived in the same way by cats across the different centres, as research would suggest that the way that cats are stroked (see Ellis *et al* 2014) and generally handled as well as the type of husbandry routines they experience may impact upon relative stress levels (e.g. Carlstead *et al* 1993 and Gourkow and Fraser 2006), and potentially affect whether people are perceived in a positive or negative way. Additionally, other physical factors within the external environment may also influence the way in which the test contexts were experienced, for example, research indicates that level of environmental disturbance (Carlstead *et al* 1993, Uetake *et al* 2013) and also unit design (McCobb 2009, Gourkow and Fraser 2006, Kry and Casey 2007) can affect general arousal and levels of stress in cats. For practical reasons, it was not possible to standardise the husbandry and socialisation routines cats from all centres were exposed to prior to the study (thus potentially some cats received greater quality/quantity of handling than others), nor the types of units cats were housed in, but such protocols could have helped to control for the potential types of effects mentioned above.

Because almost half of the refined measures brought forward from Experiment 1 were not longitudinally reliable within individuals, and three of the five that *were* longitudinally reliable were not reliable between locations (i.e. they did not maintain consistent relationships with the different social test conditions across locations)), in current form, their general reliability and thus utility in the assessment of the emotional processes of interest is limited. It is thus necessary to explore the potential for other practical methods of trait assessment that may be able to either improve the robustness of the current measures, or provide a more suitable alternative.

Observer ratings:

Providing a practical alternative to direct behavioural recordings and observations, observer ratings can potentially offer reliable and valid ways to assess or describe emergent behaviour patterns or constructs that are otherwise hard to measure directly (Mendl and Harcourt 2000). When developed under rigorous conditions, trait-based behavioural ratings have shown evidence of observer reliability and construct validity (see Carlstead *et al* 2000, Sheppard and Mills 2002, Hsu and Serpell 2003, Wright *et al* 2012) as well as convergent validity with other behavioural and physiological measures and outcomes (Wielebnowski 1999, Sheppard and Mills 2002, Momozawa *et al* 2003, Wright *et al* 2012). In the rehoming environment, a reliable and valid questionnaire-based assessment method could provide a feasible and time-efficient way to generate behavioural information that could be used to help assess emotional predisposition.

3.5 Conclusion:

By further assessing the robustness of the refined tests taken forward from Chapter 2 (Model #4), several measures were found to be longitudinally unreliable. Of the measures that *were* reliable (Model #6), several of these were also affected by location-specific social factors. It is concluded that such effects are potentially due to the differential affective and/or social quality of certain individual behaviours, which may vary within a given context/rehoming environment.

In addition, during the process of test refinement over the course of Chapters 2 and 3, measures relating specifically to aspects of RAGE in a physical context and FEAR in both social and physical contexts were removed. Whilst these removals either improved the reliability and/or practicality of the test models, such refinements ultimately reduced the scope of the tests in relation to their potential ability to identify these features of emotional processes.

Whilst basic or gross measures such as those used within the current test model benefit from their ease of use and highly practical application, their limitation in being able to qualitatively differentiate between function and/or affect is apparent. It is therefore necessary to explore the potential for other types of similarly practical methods (such as observer ratings) that could be used in conjunction with or as a replacement for the current test measures.

3.5.1 Main findings and questions raised

- Further scrutiny of the behavioural measures within the proposed test model developed in Chapter 2 identified limitations associated with their reliability in relation to temporal and environmental/social context consistency.
- Such results further highlight the associated limitations with this method of temperament assessment, and suggest other approaches should be considered.

4 Chapter 4 - The development of a questionnaire to assess behavioural traits in cats relating to aspects of FEAR, SEEKING and RAGE, within the rehoming environment:

4.1 Introduction:

Due to the identified limitations associated with the behavioural measures found in previous chapters regarding their ability to reliably isolate underlying behavioural tendency independent of social and/or physical context, it was necessary to explore alternative approaches that could either be used in conjunction with, or in the place of the current behavioural model.

4.1.1 Chapter aims:

The aims of this chapter were to design a series of behavioural questionnaires in order to facilitate the assessment of cats in relation to three key traits believed to be of importance in the successful rehoming of cats (FEAR, SEEKING and RAGE (see Chapter 1 and Table 4.1), based on human perception of cats in a rehoming centre context.

The ultimate goal of the questionnaires was to be able to reliably;

i) Predict human-sociability in cats, and;

ii) Determine the propensity of individuals to aggress towards humans.

4.1.2 Psychometric profiling:

In this chapter, the use of 'psychometric' or 'behavioural' profiling of cats by proxies (i.e. the staff working closely with the individual) is explored. Such methods have previously been used reliably in a range of non-human animal species (e.g. see Gosling *et al* 2003, Meagher 2009, Tetley, and O'Hara 2012, also Carlstead *et al* 2000, Sheppard and Mills 2002, Hsu and Serpell 2003, Wright *et al* 2012) with many demonstrating good convergent validity with other types of potentially less ‘subjective’ measures (e.g. see Wielebnowski 1999, Sheppard and Mills 2002, Momozawa *et al* 2003, Wright *et al* 2012). Observer-rating methods can therefore potentially provide a practical, reliable and valid way to assess cross-situational trait constructs and behavioural tendencies that can be otherwise difficult or impractical to measure via direct observations (Mendl and Harcourt 2000).

In several species of felids, observer/keeper ratings have been utilised successfully to predict specific behavioural and fitness outcomes (see Carlstead *et al* 1999 and Wielebnowski 1999), whilst others have been used to assess aspects of ‘personality’ (e.g. see Feaver *et al* 1986, Gosling and Bonnenburg 1998, Lee *et al* 2007, Zeigler-Hill 2010, Gartner and Powell 2012, Gartner *et al* 2014) and also ‘subjective wellbeing’ (Gartner and Weiss 2013).

4.1.3 The importance of biological relevance:

In the use of such psychometric/behavioural assessments, it is argued that measures be ‘psychologically meaningful and relevant to individuals’ (Funder *et al* 2000) and also of general biological/ecological relevance (see Réale *et al* 2007). In this regard, various previous psychometric-type assessments used in *F. silverstris* can be criticised. For example, many such questionnaires have been taken directly (or lightly adapted) from the human-psychology literature (see Feaver *et al* 1986, Gosling and Bonnenburg 1998, Zeigler-Hill 2010, Gartner and Powell 2012, Gartner and Weiss 2013, Gartner *et al* 2014), with terms such as ‘jealous’ and ‘eccentric’ (Gartner and Weiss 2013) ‘artistic’ and ‘moody’ (Gosling and Bonnenburg 1998) and ‘Cold-hearted’ (Zeigler-Hill 2010), being used to describe traits for which, from a biological or empirical perspective, there may be no clear evidence base in felids, nor in other non-human animals for that matter.

Thus, particularly when the ratings are not considered in relation to any direct behavioural measures (e.g. Turner *et al* 1986, Gosling and Bonnenburg 1998, Lee *et al* 2007, Weilbenowski 2002, Zeigler-Hill 2010, Gartner and Weiss 2013), no inter or intra-individual reliability of ratings is demonstrated (Lee *et al* 1983, Gosling and Bonnenburg 1998, Zeigler-

Hill 2010), or when no relationship between personality ratings and behavioural observations is actually found (Iki *et al* 2011), the general construct validity of such measures are questionable.

4.1.4 Study objectives:

Bearing these previous limitations in mind, the objective of this chapter was to develop a biologically relevant behavioural assessment questionnaire for staff working with cats within a rehoming environment, which could provide a practical source of information in relation to the outlined traits of interest (see Chapters 1 & 2). The second objective was to assess the reliability of the questionnaire, both within and between different staff-raters, as well as over time, retaining only the most reliable items to develop a revised questionnaire. The third objective was to assess the convergent and content (or face validity) (see Messick 1990) of the revised questionnaire in light of the specific aspects of the underpinning theoretical framework upon which they were based (i.e. see Chapter 1 and Table 4.1). The final model could then be taken forward and explored further in relation to convergent (i.e. with the behavioural test measures) and predictive validity (i.e. with owner reports of behaviour post-adoption) in further chapters, to help further determine the overall construct validity of the tests.

4.2 Methods

4.2.1 Questionnaire development:

4.2.1.1 Item content:

An initial behavioural questionnaire (QA1) was developed using the same underpinning theoretical frame-work and operational definitions used previously in the development of the behavioural tests and test measures (see Table 4.1 below and Chapters 2-3). Each item was linked to one or more of the specific core emotional processes of interest (FEAR, SEEKING, RAGE) and aimed to represent these across both social and non-social contexts. Items were based around what were anticipated to be relatively common every-day situations during human-cat interactions and husbandry routines, where a greater frequency or intensity of a specific behavioural response was anticipated to relate to high reactivity of the FEAR, SEEKING or RAGE systems (or in some instances their combinations), and thus a greater expression of the associated traits of interest (see Table 4.1 below). Items and their corresponding core processes were initially mapped out in table format to ensure each process and context was sufficiently covered across the questionnaire as a whole (See Table 4.2). A total of 28 items were included in the questionnaire, each a descriptive statement relating to the behaviour of the cat. Items were designed to gauge either how often a specific type of behavioural response occurred (i.e. how often the cat behaved aggressively when stroked), or how closely the description of the cat matched the person's perception of them (i.e. 'this cat is friendly') (See appendix 4.1 for example of questionnaire format).

Table 4.1 Proposed operational definitions for the individual traits of interest in the relation to the prediction of 'human-sociability' and the 'aggressive response' in the domestic cat.

Individual 'traits'	**Definition**	**Potential emotional states/processing systems involved (*sensu* Panksepp 1998)**	**Relevance of trait**
Sociability	The tolerance of proximity to others, and a willingness or desire to interact with others	SEEKING RAGE	Potential important mitigators of the manifestation of "human-sociability" in cats
Boldness	A neophilia with the absence of fear	FEAR SEEKING	
Gregariousness	(The combination of both sociability and boldness): The active seeking out of the company of others (either known or unknown)	SEEKING FEAR RAGE	
Frustration reactivity	A negative emotional predisposition associated with the denial of an incentive, the denial of control or when expectations are not met.	SEEKING RAGE	Potential important mitigator of the "aggressive response" in cats
Fearfulness	A negative emotional predisposition associated with a threat or presence of an aversive stimulus.	FEAR	

4.2.1.2 Respondent demographics:

The questionnaire was designed to be filled in by rehoming centre staff working directly with a specific cat (e.g. feeding, cleaning, socialising) on a daily basis, for a period of at least seven days prior to filling in the questionnaire. All staff were considered eligible to fill in a questionnaire regardless of their level of previous experience working with cats or duration of time working at that particular centre, although these details were recorded.

4.2.1.3 Questionnaire specification:

The questionnaire used a five-point ratings or Likert scale (Likert 1932), with answers to statements placed on a scale ranging from ‘strongly disagree’ to ‘strongly agree’. Such types of scales are particularly relevant when assessing constructs such as personality or temperament, where individuals are more likely to exist upon a spectrum, rather than a dichotomy (e.g. see Nettle 2005).

‘Unsure’ and (where deemed relevant) ‘not applicable’ were also included as response options for each item. This ensured that at no point were people forced to provide an answer, increasing the likelihood that answered items reflected aspects of the cats’ behaviour the person felt relatively confident about. Providing ‘Unsure’ and ‘n/a’ options also enabled the identification of potentially more ambiguous or hard to answer items within the questionnaire, which could then be removed (because they are generally less likely to provide consistent or reliable information about the cat).

As well as determining where individual cats appeared to lie on a ‘trait’ spectrum, rating scales for some items were designed to assess the stability of particular behavioural tendencies (such as human-directed aggression) across different physical and social contexts, for example during play (e.g. ‘This cat has got carried away during play, which has led to me being bitten or swiped at’), during social interactions (e.g. ‘This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it’) and also during handling for medical procedures (e.g. ‘This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I performed routine health procedures (such as grooming/ carrying out health checks or when administering medication, etc.)'. This was important in order to try to differentiate between behavioural responses which may be more context-specific, from those which are more consistent and thus potentially indicative of underlying temperament. In this case the items related to specific situations, and scales of measurement were frequency-based and ranged from 'never' to 'always', (again on a five point scale), thus a high frequency rating for each of the above examples relating to human-directed aggression might suggest a cat high in RAGE reactivity.

The questionnaire was designed so that its internal validity could be assessed via the determination of convergent and discriminant validity (where several items that each aim to measure different aspects of the same construct (i.e. SEEKING) group together, and are also distinct from other groups of measures (such as those relating to FEAR or RAGE).

The addition of reversed scaling for some items is also useful in helping to avoid respondent acquiescence (for example people that will always 'strongly agree' or 'strongly disagree' with a statement) (see Messick 1967, DeVellis 1991, Sheppard and Mills 2002). In this way, a person who is filling in a questionnaire about a very sociable cat will not simply be able to score at the same end of a scale for each of the questions asked about the cat's behaviour towards people. Scores could then be reversed where necessary so that all related items were directly comparable and collective scores for multiple items could be generated where appropriate.

Rather than grouping questions based on their similarity, the questions were randomly ordered within the questionnaire to promote maximum attendance to each specific question being asked, again discouraging participant 'acquiescence'. Measurement scale lengths were also standardised for all questions to allow for more effective statistical analysis of the data.

Table 4.2 Outline of Questionnaire A.1 items designed to be filled in by staff members within the rehoming environment. Questionnaire items are mapped against specific behavioural traits, their hypothesised relationship with underpinning emotional processes (marked with an 'X') and whether they involve social elements (s) (i.e. in relation to the human in an interactive capacity), or physical elements (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

Questionnaire A.1	**Sociability (social) SEEKING**	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability/flexibility**	**Rehomeability**
1) This cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)				**X(s)**		**X(s)**			
2) This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks				**X(s)**		**X(s)**			
3) This cat is comfortable being picked up	**X(s)**	**X(s)**	**X(s)**						

	Sociability (social) SEEKING	Boldness (social/physical) SEEKING with the absence of FEAR	Gregariousness (Sociability + boldness)	Fearfulness (Social/physical) FEAR	Propensity to aggress (Social/physical) RAGE	Frustration reactivity (Social) RAGE	Resource motivated-ness (Physical) SEEKING-	Behavioural stability/flexibility	Rehomeability
4) When I try to initiate contact or interaction with the cat, it doesn't move away but is quiet and not very responsive towards me (i.e. it doesn't purr or rub against me)				**X(s)**					
5) This cat is timid				**X(s,p)**					
6) This cat will approach me when I enter its unit/pen to say 'hello' (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss		**X(s)**				**X(s)**			
7) This cat is vocal around people	**X(s)**					**X(s)**			
8) This cat will <u>actively approach</u> me in order to ask for attention and to initiate contact with me (e.g. the cat comes and sits on my knee, or rubs	**X(s)**	**X(s)**	**X(s)**						

up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)									
	Sociability (social) SEEKING	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability/flexibility**	**Rehomeability**
9) This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it				**X(s)**	**X(s)**	**X(s)**			
10) This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I performed routine health procedures (such as grooming/ carrying out health checks or when administering medication, etc.)				**X(s)**	**X(s)**	**X(s)**			
11) This cat is keen to explore new things in its environment		**X(p)**					**X(p)**		

12) This cat takes a long time to settle and to adapt to change in its environment		**X(p)**					**X(p)**		
	Sociability (social) SEEKING	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability/flexibility**	**Rehomeability**
13) This cat is playful	**X(s)**						**X(p)**		
14) This cat has got carried away during play, which has led to me being bitten or swiped at					**X(p)**	**X(p)**			
15) If this cat could choose, it would prefer to be left alone, rather than be with people	**X(s)**								
16) This cat likes being stroked	**X(s)**	**X(s)**	**X(s)**						
17) I have avoided stroking or handling this cat because I feel that it doesn't want me to				**X(s,p)**	**X(s)**	**X(s)**			
18) This cat is very tolerant of being handled	**X(s)**	**X(s)**	**X(s)**						

19) I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)				**X(s)**	**X(s)**	**X(s)**			
	Sociability (social) SEEKING	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability/flexibility**	**Rehomeability**
20) When I am around this cat, it seems angry						**X(s)**			
21) If this cat could choose, it would prefer to have a bowl of food rather than interact with me							**X(p)**		
22) This cat is more keen to interact with me and be near me when I have food /treats							**X(p)**		
23) This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)								**X**	

24) This cat behaves differently with strangers than it does with me				**X(s)**				**X**	
25) This cat behaves differently with other members of staff than it does with me				**X(s)**				**X**	
26) This cat is friendly	**X(s)**	**X(s)**	**X(s)**						
27) This cat is fearful				**X(s,p)**					
28) The temperament and behavioural style of this cat will make it is easy to rehome									**X**

4.2.2 Data collection:

Four UK rehoming centres agreed to assist with data collection. Questionnaires were distributed between October 2013 and February 2014, with 168 usable questionnaires being returned (67 from BDCH, 51 from WG, 21 from MHW and 28 from Cats Protection (CP)). The majority of questionnaires were sampled from cats that were involved in Experiment 2 behaviour tests (see Chapter 3), with the exception of CP where no behavioural data was collected. A total of 39 different staff members were involved in filling in the questionnaires (12 from BDCH, seven from WG, five from MHW and 15 from CP).

Across the centres, where possible, the following further questionnaire sampling protocols were implemented:

- To assess intra-rater reliability, a member of staff was asked to fill in two QA.1 questionnaires for the same cat within a week of each other (with a minimum gap of at least two days).

- To assess inter-rater reliability, two different members of staff were asked to fill in an A.1 questionnaire for the cat, within a week of each other (with a minimum gap of at least two days).

- To assess longitudinal stability, members of staff were asked to fill in a second questionnaire for the same cat after a three to four week period (this could be either the same or a different person depending upon who was currently working with the cat at the time of the second questionnaire).

Cats were sampled opportunistically depending upon staff time and acquiescence as well as whether the cat remained in the rehoming centre long enough for multiple questionnaires to be filled in. Not all cats were therefore sampled equally across the above sampling components, and as such data populations and sample sizes varied depending upon the specific phase of analysis being carried out, with sample sizes ranging from 14-41 depending upon the specific item (specific sizes for each question analysed are given in results Table 4.3).

4.2.3 Data analysis:

4.2.3.1 Assessment of item reliability:

To ensure the reliability and overall 'robustness' of individual questionnaire items, data collected from all centres were pooled and the following analyses and refinement process were carried out. The analysis consisted of four stages. For each stage, data from individuals were only included if a cat had a score for both items that were being compared (i.e. no question had been left blank or answered with a 'U' or an 'n/a').

i) *Removal of potentially ambiguous items*

Initially individual questionnaire items that had a response rate of <90% (i.e. 11% or more of the items were missing a rating) were identified and excluded from the subsequent analysis.

ii) *Assessment of intra-rater reliability:*

Intra-rater repeatability of the remaining individual items was assessed from questionnaire data where the same responder had filled out two QA.1 (staff) questionnaires on the same cat within seven days of each other. For the majority of cats, this rater was also the 'familiar' person in the behavioural tests.

iii) *Assessment of inter-rater reliability:*

Inter-rater reliability was assessed on individual questionnaire items where two different responders (that both met criteria) had filled out a QA.1 questionnaire on the same cat within seven days of each other. Only items that demonstrated significant intra-rater repeatability were used in this phase of the analysis.

iv) *Assessment of temporal/longitudinal reliability:*

Items that had significant intra and inter-rater repeatability were then further assessed for their longitudinal stability. This was performed on all remaining items taken from cats that had two or more QA.1 questionnaires filled out, with a gap of between three to four weeks in between the first and second questionnaire.

Because staff were often rotated amongst different areas of the cattery (thus not looking after the same cats for long periods of time), and the person filling out the questionnaire had to have recently spent time with the cat in order to fill out a questionnaire, for some cats these two questionnaires were filled out by the same person, for others they were filled out by two different people. Whilst this precluded the assessment of longitudinal repeatability for inter and intra-raters separately, items that demonstrated significant temporal repeatability in spite of potential variability between observers could be considered to be substantially robust (a particularly desirable outcome in relation to the general reliability of the questionnaire).

All analyses were carried out in R software (version 3.1.0) (R Development Core Team, 2014). Intra, inter and longitudinal rater reliabilities were assessed by extracting the Intra Class Correlation Coefficients (ICC) for each two samples being compared. Different ICC ratings were extracted depending upon whether the rater should be viewed as a fixed or random effect. Thus where the two samples were filled in by the same individual, ICC3 ('a fixed set of k judges rate each target') coefficients were extracted. Where the two samples were rated by different people, ICC2 ('a random sample of k judges rate each target') coefficients were used (Revelle 2014, *taken from* Shrout and Fleiss 1979).

All ICC's were calculated using the *ICC* command from the *psych* package (Revelle 2014). For each ICC test, alpha was set at 0.5.

4.2.3.2 Item convergence and cluster interpretation:

The remaining items that were longitudinally repeatable were then assessed for their relationship to one another and to the primary emotional processes they were designed to measure aspects of using Hierarchical Clustering (HCA) techniques. For this phase of analysis, data were initially taken from all individuals (*n=168*), however individuals with missing scores for any of the items were subsequently excluded prior to analysis, leading to the sampled population containing a total of 104 individuals.

Hierarchical Cluster Analysis with Euclidian distancing and corresponding dendrogram were performed on the longitudinally reliable measures identified in stage (iv) (see Table 4.4), using the *hclust* function from the *stats* package (R Core Team 2013). The HCA dendrogram was then 'cut' at a place where several distinct clusters of measures could be identified. In accordance with the third objective, items within each cluster were then assessed for convergent and content validity in terms of their hypothesised relation to the primary emotional processes of interest (RAGE, SEEKING, FEAR) in either physical or social contexts, to determine if measures that were hypothesised to relate to the same emotional processes actually clustered together, and whether all processes of interest were represented.

4.3 Results: (see Table 4.3 for summary of results)

4.3.1 Item reliability:

Of the 28 initial items, ten had a response rate of <90% and were thus removed prior to data analysis. The majority of these items related to situations that rehoming staff had not experienced with the cat and as such felt unable to answer (for example whether the cat behaves aggressively during health procedures, or whether the cat is comfortable being picked up).

Of the 18 remaining items assessed for intra-rater reliability, only one was found to be unreliable ('If this cat could choose, it would prefer to be left alone, rather than be with people'), suggesting that this aspect of a person's impression of a cat is not stable even over a short period of time.

Of the 17 items that were then assessed for inter-rater reliability, six were found to be unreliable. These were primarily items relating to 'interactive' situations (such as 'This cat will actively approach me in order to ask for attention and to initiate contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)' and also 'This cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)').

During the final stage of longitudinal stability analysis performed on the remaining 11 items, only one item was found to be unreliable, which again related to an 'interactive' situation ('I have avoided stroking or handling this cat because I feel that it doesn't want me to'). Thus a total of ten remaining items were found to be significantly repeatable across all situations that were assessed. Collectively, this refined group of items still covered a range of aspects relating the primary core process of interest (FEAR, SEEKING and RAGE), thus demonstrated a level of content validity, but predominantly in social rather than non-social contexts (See Table 4.4). This group of reliable items was then named the Lincoln Cat Assessment Test (L-CAT).

Table 4.3 Summary of reliability results from the Interclass correlation coefficients (ICC) performed on questionnaire QA.1 items at each stage of analysis. Results in bold indicate a significant level of repeatability at each stage and questions in bold indicate significant repeatability across all stages.

	Full question	N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC3)	F value / Degrees of freedom:	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for Inter-rater repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for longitudinal repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals
1)	This cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)	**N=40 ICC3= 0.57**	**F=3.7 Df=39,39**	**P<0.0001*** CI= 0.32, 0.75**	N=26 ICC2=0.25	F=1.7 Df= 25,25	P>0.05 CI=-0.14, 0.57	NA	NA	NA
2)	**This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks**	**N=40 ICC3=0.49**	**F=2.9 Df=39,39**	**P<0.001** CI= 0.21, 0.69**	**N=24 ICC2=0.58**	**F=3.7 Df= 23,23**	**P<0.01* CI= 0.24, 0.79**	**N=32 ICC2=0.55**	**F=3.4 Df=31,31**	**P<0.001** CI= 0.25, 0.75**
3)	This cat is comfortable being picked up	Item excluded as response rate <90%								

Full question		N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC3)	F value / Degrees of freedom:	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for Inter-rater repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for longitudinal repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals
4)	When I try to initiate contact or interaction with the cat, it doesn’t move away but is quiet and not very responsive towards me (i.e. it doesn’t purr or rub against me)	**N=40 ICC3=0.6**	**F=2.5 Df=39,39**	**P<0.01* CI= 0.15, 0.66**	N=25 ICC2=0.24	F=1.6 Df=24,25	P>0.05 CI= -0.153, 0.58	NA	NA	NA
5)	**This cat is timid**	**N=40 ICC3= 0.86**	**F=14 Df=39,39**	**P<0.0001*** CI= 0.76 0.93**	**N=26 ICC2=0.59**	**F=3.8 Df=25,25**	**P<0.001** CI= 0.27, 0.79**	**N=32 ICC2=0.82**	**F=9.8 Df=31,31**	**P<0.0001*** CI= 0.66, 0.91**
6)	This cat will approach me when I enter its unit/pen to say ‘hello’ (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss	**N=39 ICC3= 0.65**	**F=4.7 Df=38,38**	**P<0.0001*** CI= 0.42, 0.80**	N=26 ICC2=0.108	F=0.81 Df=25,25	P>0.05 CI= -0.49,0.30	NA	NA	NA
7)	**This cat is vocal around people**	**N=32 ICC3= 0.62**	**F=4.2 Df=31,31**	**P<0.0001*** CI= 0.35, 0.79**	**N=22 ICC2=0.64**	**F=4.5 Df=21,21**	**P<0.001** CI=0.31, 0.84**	**N=27 ICC2=0.66**	**F=4.7 Df=26,26**	**P<0.0001*** CI= 0.37,0.83**

Full question		N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC3)	F value / Degrees of freedom:	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for Inter-rater repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for longitudinal repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals
8)	This cat will actively approach me in order to ask for attention and to initiate contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)	**N=37 ICC3= 0.63**	**F=4.4 Df=36,36**	**P<0.0001*** CI= 0.39, 0.79**	N=26 ICC2=0.17	F=1.4 Df=25, 25	P>0.05 CI= -0.19,0.51	NA	NA	NA
9)	**This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it**	**N=40 ICC3=0.45**	**F=2.7 Df=39,39**	**P<0.01* CI= 0.17, 0.67**	**N=24 ICC2=0.75**	**F=6.7 Df=23 ,23**	**P<0.0001*** CI= 0.49,0.88**	**N=33 ICC2=0.70**	**F=5.5 Df=32,32**	**P<0.0001*** CI= 0.47, 0.84**
10)	This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I performed routine health procedures (such as grooming/ carrying out health checks or when administering	Item excluded as response rate <90%								

	medication, etc.)									
11)	This cat is keen to explore new things in its environment	Item excluded as response rate <90%								
12)	This cat takes a long time to settle and to adapt to change in its environment	Item excluded as response rate <90%								
13)	This cat takes a long time to settle and to adapt to change in its environment	Item excluded as response rate <90%								
14)	This cat has got carried away during play, which has led to me being bitten or swiped at	Item excluded as response rate <90%								
15)	If this cat could choose, it would prefer to be left alone, rather than be with people	N=34 ICC3= 0.28	F=1.8 Df=33,33	P>0.05 - CI= 0.058, 0.56	NA	NA	NA	NA	NA	NA
16)	**This cat likes being stroked**	**N=37 ICC3= 0.31**	**F=1.9 Df=36,36**	**P<0.05* CI= -0.0165, 0.57**	**N=22 ICC2=0.42**	**F=2.4 Df=21,21**	**P<0.05* CI= 0.0144, 0.71**	**N=30 ICC2=0.41**	**F=2.3 Df= 29,29**	**P<0.05* CI= 0.055, 0.67**
17)	I have avoided stroking or handling this cat because I feel that it doesn’t want me to	**N=39 ICC3= 0.81**	**F=9.4 Df=38,38**	**P<0.0001*** CI= 0.66 ,0.89**	**N=26 ICC2=0.62**	**F=4.2 Df= 25,25**	**P<0.001** CI= 0.32, 0.81**	N=33 ICC2=0.96	F=47 Df=32,32	P>0.05 CI= 0.92,0.98
18)	This cat is very tolerant of being handled	Item excluded as response rate <90%								

Full question		N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC3)	F value / Degrees of freedom:	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for Inter-rater repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for longitudinal repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals
19)	**I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)**	**N=41 ICC3= 0.88**	**F=16 Df=33,33**	**P<0.0001*** CI= 0.77 ,0.94**	**N=26 ICC2=0.70**	**F=5.4 Df=25 ,25**	**P<0.0001***, CI= 0.43, 0.85**	**N=34 ICC2=0.94**	**F=16 Df=33,33**	**P<0.0001*** CI= 0.78 ,0.94**
20)	**When I am around this cat, it seems angry**	**N=40 ICC3=0.53**	**F=3.3 Df=39,39**	**P<0.001** CI= 0.27, 0.72**	**N=25 ICC2= 0.66**	**F=5.0 Df=24, 24**	**P<0.0001*** CI= 0.38, 0.84**	**N=33 ICC2= 0.67**	**F=5.0 Df= 32,32**	**P<0.0001*** CI= 0.43 ,0.82**
21)	If this cat could choose, it would prefer to have a bowl of food rather than interact with me	Item excluded as response rate <90%								
22)	This cat is more keen to interact with me and be near me when I have food /treats	Item excluded as response rate <90%								
23)	**This cat has changed in the way it interacts with me since I first started working with it (e.g. has become <u>less</u> fearful, has become <u>more</u> fearful, behaves <u>more</u>**	**N=41 ICC3=0.46**	**F=2.7 Df=30,30**	**P<0.01* CI= 0.13, 0.69**	**N=25 ICC2=0.36**	**F=2.1 Df=24, 24**	**P<0.05* CI= -0.045, 0.66**	**N=31 ICC2=0.46**	**F=2.7 Df=30,30**	**P<0.01* CI= 0.13, 0.70**

	aggressively, behaves less aggressively, is less friendly, is more friendly)									
Full question		N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC3)	F value / Degrees of freedom:	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for Inter-rater repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals	N=number of cats sampled / Intraclass Correlation Coefficient for longitudinal repeatability (ICC2)	F value / Degrees of freedom	P value / confidence intervals
24)	This cat behaves differently with strangers than it does with me	**N=14** ICC3= **0.55**	F=**3.4** Df=**13,13**	P<**0.05*** CI= **0.045 ,0.83**	N=18 ICC2=0.27	F=1.7 Df= 17, 17	P>0.05 CI= -0.23, 0.65	NA	NA	NA
25)	This cat behaves differently with other members of staff than it does with me	Item excluded as response rate <90%								
26)	**This cat is friendly**	**N=36 ICC3= 0.43**	**F=2.5 Df=35,35**	**P<0.01* CI= 0.12, 0.66**	**N=25 ICC2=0.43**	**F=2.5 Df=24, 24**	**P<0.05* CI= 0.057 ,0.70**	**N=30 ICC2=0.68**	**F=5.2 Df=29,29**	**P<0.0001*** CI= 0.43, 0.83**
27)	This cat is fearful	**N=41 ICC3= 0.83**	**F=11 Df=40 ,40**	**P<0.0001*** CI= 0.70, 0.90**	N=26 ICC2=0.25	F=1.7 Df=25 25	P>0.05 CI= -0.15, 0.58	NA	NA	NA
28)	**The temperament and behavioural style of this cat will make it is easy to home**	**N=40 ICC3= 0.67**	**F=5.1 Df=39,39**	**P<0.0001*** CI= 0.46, 0.81**	**N=26 ICC2=0.58**	**F=3.6 Df=25, 25**	**P<0.0001*** CI= 0.25, 0.79**	**N=33 ICC2=0.75**	**F=6.8 Df=32,32**	**P<0.0001*** CI= 0.55, 0.87**

Table 4.4 Reliable QA.1 items identified from Table 4.3 (subsequently referred to as the Lincoln Cat Assessment Test (L-CAT)), mapped against specific behavioural traits and their hypothesised relationship to underpinning emotional processes (marked with an 'X') whether in a social (s) (i.e. in relation to the human in an interactive capacity), or physical context (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

Repeatable QA.1 (staff) items	**Sociability (social) SEEKING**	**(social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social/physical) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability/flexibility**	**Rehomeability**
2) This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks				**X(s)**		**X(s)**			
5) This cat is timid				**X(s,p)**					
7) This cat is vocal around people	**X(s)**					**X(s)**			
9) This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it				**X(s)**	**X(s)**	**X(s)**			
16) This cat likes being stroked	**X(s)**	**X(s)**	**X(s)**						
19) I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)				**X(s)**	**X(s)**	**X(s)**			

20) When I am around this cat, it seems angry						**X(s)**			
23) This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)								**X**	
26) This cat is friendly	**X(s)**	**X(s)**	**X(s)**						
28) The temperament and behavioural style of this cat will make it is easy to rehome									**X**

4.3.2 Item convergence and cluster interpretation:

From the HCA dendrogram performed on the refined items, three distinct clusters of measures were identified (sSQ, sRQ and sFQ, see Figure 4.1). As items within Cluster sSQ predominantly related to social SEEKING, this was the overall interpretation given to this cluster. The majority of items within Clusters sRQ and sFQ related to social aspects of RAGE and FEAR respectively and were as such used as the main interpretations for these clusters (See Table 4.5).

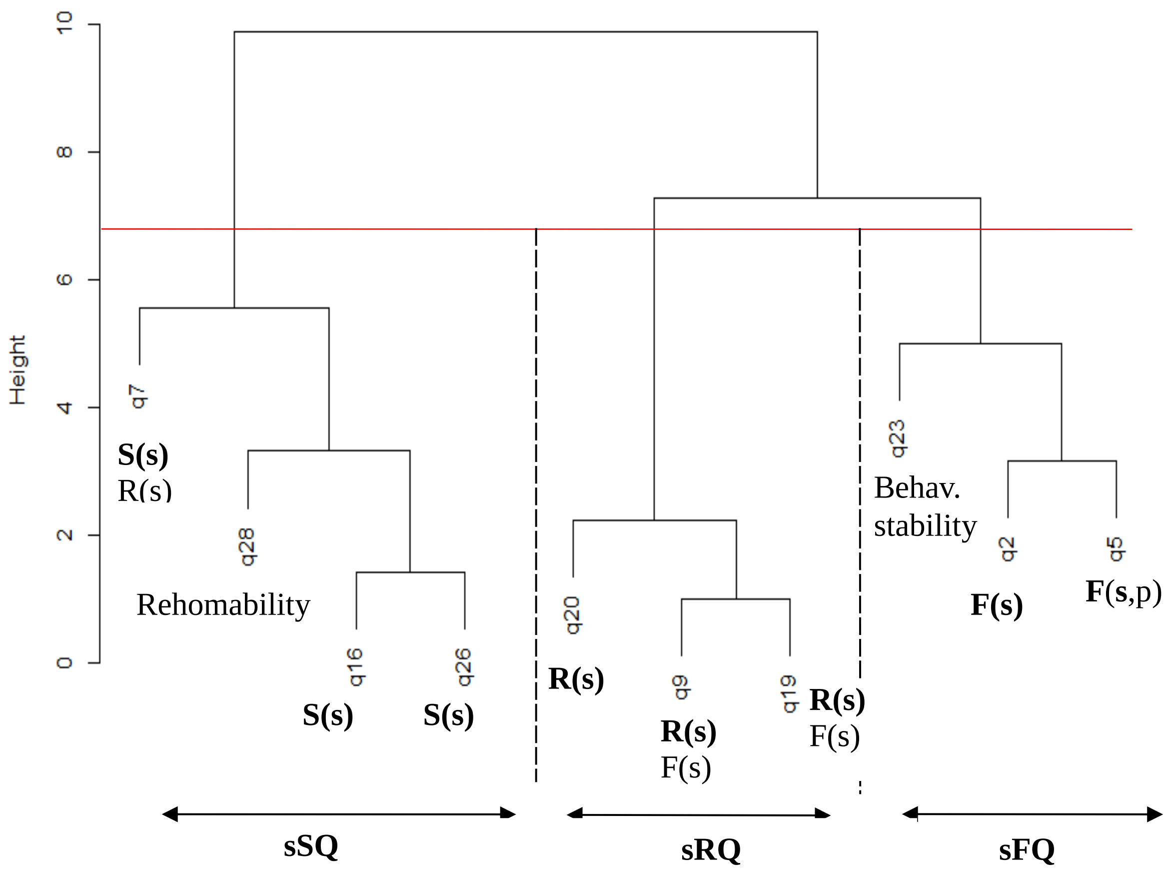

Figure 4.1 'Questionnaire items' Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on reliable questionnaire items as summarised in Table 4.4. Dendrogram of test measures produced using average linkage between groups based on binary squared Euclidean

distance matrix. Data taken from ten L-CAT items from a population of 88 individual cats across four separate rehoming centres (BDCH, CP, MHW, WG). The central vertical black dotted lines represent the three main clusters (social SEEKING (**sSQ**), social RAGE (**sRQ**) and social FEAR (**sFQ**)) that were apparent within the dendrogram, whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters. Each item is represented in relation to the predicted primary emotional processes (and their context) of relevance (see also Table 4.5 below).

Table 4.5 List of repeatable individual L-CAT items (based on the results of Table 4.4) in each cluster from the HCA dendrogram, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. For a full description of each cluster item, refer to Table 4.2.

sSQ	Emotional processes and context	**sRQ**	Emotional processes and context	**sFQ**	Emotional processes and context
Q7	**S (s),** R(s)	Q9	**R(s)** F(s)	Q2	**F (s)**
Q16	**S (s)**	Q19	**R(s)** F(s)	Q5	**F** (**s,** p)
Q26	**S (s)**	Q20	**R (s)**	Q23	'Behavioural Stability'
Q28	'Rehome-ability'				
Interpretation of each cluster:					
SEEKING (primarily in a **social** context)		**RAGE** (primarily in a **social** context)		**FEAR** (primarily in a **social** context)	

4.4 Discussion:

Of the 28 items included within the QA.1 (staff) questionnaire, a total of ten were found to be reliable within and between people over short as well as a longer time periods. The final model, (the 'Lincoln Cat Assessment Test' (L-CAT)) as it is intended for use is presented in appendix 4.2.

The initial items that were removed due to lower response rates amongst staff generally related to situations that may not happen frequently or consistently enough within the rehoming environment for staff to feel certain about the cats' behaviour in such contexts. These items are therefore less likely to provide useful or consistent information about the cat.

The majority of the items that did not attain sufficient levels of inter-rater agreement were those that related specifically to cat-human interactions. This would seem to suggest that either;

i) The behaviour of the cat is consistent with different people, but it is the perception of the behaviour that varies depending upon certain aspects or characteristics of a person;

ii) Or, the behaviour of the cat is variable with different people (and peoples' perceptions of behaviour may or may not vary).

Whilst there is some evidence to suggest that factors relating to the individual characteristics and previous experiences of a person *can* affect their perception of and attitudes towards animals (e.g. see Serpell 1996; 2004, Adamelli *et al* 2005, Zeigler-Hill and Highfill 2010, Meyer and Forkman 2014), in interactive situations, it is likely that these characteristics not only change the way in which people interact with the animal, but also affect how the animal behaves in return (see Wedl *et al* 2011). It is therefore more probable that it is the persons' style of interaction, rather than their inherent perceptual bias that is likely to have the greatest effect on their subsequent rating of a cats' behaviour, particularly in the case where they are asked to comment on the incidence of specific behavioural responses (as is the case with the QA.1 'interactive' questionnaire items), rather than on a more general behavioural impression. Results from the reliability analyses carried out on the individual behavioural measures in Chapters 2 and 3 would also tend to lend support to the latter hypothesis. Both the frequency and duration of many of the cat-human interactive behaviours analysed were found to vary not only with the familiarity of the person but also with their interaction style (See Chapters 2 and 3).

Taken collectively, these results would seem to suggest that for many specific behaviours, *who we are* as well as *how we behave* may influence the responses of cats, and as a consequence how we rate their behaviour. This ultimately highlights the importance of using standardised assessment protocols when carrying out behavioural tests with the aim being to reliably assess the behaviour and underlying temperament of cats, particularly in relation to their interactions with people, although such standardised approaches have not always been used (for example Lee *et al* 1983, Feaver *et al* 1986, Turner *et al* 1986, Bradshaw and Cook 1996, Lowe and Bradshaw 2001, Seigford *et al* 2003).

Of the items with high inter-rater agreement, all but one were also high for longitudinal repeatability, indicating that the behavioural items that are stable between people are also generally those that are consistent in cats over time, and are thus likely to reflect stable or 'robust' behavioural elements relating to aspects of the cats' temperament.

The nature of the groupings of individual questionnaire items within and between each of the three HCA dendrogram clusters suggest a good level of convergent and also discriminant validity of items in relation to their hypothesised underpinning emotional components, thus suggesting a level of construct validity. For example within a cluster, all items were easily identifiable based on their shared relationship with the same components (i.e. all relating to social SEEKING), whilst between clusters they were also easily differentiable (i.e. SEEKING (sSQ) versus RAGE (sRQ) versus FEAR (sFQ)). The clusters of questionnaire items demonstrated good content validity in relation to the social aspects of all emotional processes of interest however as with the final behavioural test model, the L-CAT did not contain any measures hypothesised to relate to RAGE in a primarily physical context, (nor were physical contexts represented for either SEEKING or FEAR), and such findings would further support the conclusions of Chapter 3 - that a more qualitative assessment approach may be needed in order to improve test assessment specificity in relation to these aspects of emotional process and their identification at a behavioural level.

4.5 Conclusions:

It can be concluded that items contained within the L-CAT are generally robust and can potentially be used reliably to assess hypothesised aspects of SEEKING, FEAR and RAGE in relation to social contexts in cats in a rehoming environment. Such results may help to extend the range of information that can be gathered during the general assessment process (i.e. by viewing the L-CAT and behavioural measures in combination), because the final Behavioural test model did not contain any measures relating to FEAR in cats (they had been previously discarded in the initial measure refinement process either for practical reasons or due to their unreliability (see Chapter 2)). Thus the L-CAT may prove particularly useful in relation to the assessment of this specific emotional process (within a social context).

Furthermore, because the SEEKING measures within the L-CAT are hypothesised to relate to social contexts only, their relationship with the SEEKING Behavioural test measure cluster (s/pSB, see Chapter 3) may further assist in its interpretation, because currently the measures within it are thought to potentially relate to either social and/or physical aspects of SEEKING.

Currently however, the relationship between the behavioural test measures and the L-CAT remains unknown. In relation to the assessment of convergent validity of measures, this is particularly important to determine, as is the predictive validity of the L-CAT items in relation to future post-adoption behaviour. These issues are explored in subsequent chapters.

4.5.1 Main findings and questions raised:

- The results of this chapter suggest a questionnaire-based approach may provide a practical and reliable method to assess aspects of behavioural tendency in cats within the rehoming centre context.

- Such findings would suggest that staff member's perceptions of a cat over time (based on a series of unstructured encounters), are generally more reliable than observations of behaviour taken during structured tests contexts (e.g. see previous chapters). However, the initial presence of many unreliable items found within the full questionnaire model suggests that careful selection of individual measures is a vital function in the development of a reliable questionnaire tool.

5 Chapter 5 - Assessing the relationship between behavioural test and questionnaire data collected within the rehoming environment:

5.0 Chapter aims:

The aim of this chapter was to;

- Part 1: Assess the convergent validity of refined behavioural test measures (see Chapter 3) and staff questionnaire (L-CAT) data (see Chapter 4) within the rehoming centre.

And,

- Part 2: For cats where no behavioural test data was collected (due to missed conditions as a consequence of 'handling issues' (i.e. the cat could not be safely and calmly placed in the carrier (for example they attempted to bite or swipe the handler with claws unsheathed)), assess the predictive relationship between handling issues and staff questionnaire (L-CAT) data.

5.1 Part 1: Assessing the convergent validity between behavioural measures and the (L-CAT):

5.1.1 Introduction:

In the assessment of specific underlying constructs (such as temperament traits), high convergence between (in particular) different types of measurements (i.e. direct observations versus questionnaire ratings) that are underpinned by the same theoretical framework (e.g. Table 4.1) is important and helps to demonstrate general construct validity of the measures intended for use (i.e. the extent to which the measures are able to measure the broad construct that they are designed to) (Taylor and Mills 2006). L-CAT clusters (Table 5.1) were analysed in conjunction with refined behavioural test measure clusters (Table 5.2) in order to assess their relationship to one another and to the underpinning emotional systems they had been designed to measure aspects of.

Table 5.1 List of items from the 'Lincoln-Cat Assessment Test (L-CAT)' in each cluster (reproduced from Table 4.5, Chapter 4), their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation give to each cluster. Cluster sSQ contains questionnaire items that represent social SEEKING, cluster sRQ social RAGE, and cluster sFQ social FEAR. For a full description of each cluster item, refer to Table 4.2, Chapter 4.

sSQ	Emotional processes and context	**sRQ**	Emotional processes and context	**sFQ**	Emotional processes and context
Q7	S (s), R(s)	Q9	R(s) F(s)	Q2	F (s)
Q16	S (s)	Q19	R(s) F(s)	Q5	F (s, p)
Q26	S (s)	Q20	R (s)	Q23	F (s) R (s)
Q28	Rehome-ability				
Interpretation of each cluster:					
SEEKING (primarily a **social** context)		RAGE (primarily a **social** context)		FEAR (primarily a **social** context)	

Table 5.2. List of reliable behavioural test measures in each cluster of Model #4 (reproduced from Table 3.6, Chapter 3) their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster sRB contains behavioural measures that represent social RAGE, whilst cluster s/pSB social and/or physical SEEKING. For a full description of each cluster measure, refer to Table 2.8 in Chapter 2.

sRB:	Emotional processes and context	**s/pSB:**	Emotional processes and context
em_voc_tot_f_a	R(s)	em_app_tot_f_p	S(s p)
em_voc_tot_u_p	R(s)	em_app_tot_u_p	S(s p)
em_voc_tot_u_a	R(s)		
Interpretation of each cluster:			
RAGE:-(primarily a **social** context)		**SEEKING** (in a **social** and/or **physical** context)	

5.1.2 Methods:

5.1.2.1 Procedure:

Data was collected from 88 individual cats across the three centres where behavioural tests had been carried out (BDCH *(n=40)*, MHW *(n=16)* and WG *(n=32)*). Collective cluster scores for each individual were generated for both the Behavioural measure and L-CAT data, based on the clusters previously identified (see Table 5.1 and 5.2). Thus each cat was given two Behavioural measure (Clusters sRB and s/pSB) and three L-CAT cluster scores (Clusters sSQ, sRQ and sFQ) (Refer to Table in appendix 5.1 for full list of all cats and individual behaviour and questionnaire cluster scores). To aid in the interpretation of model outputs, the scales of some questionnaire items were reversed so that each cluster score would represent a high value for the predominant underpinning emotional process hypothesised (i.e. FEAR, SEEKING or RAGE). Only individuals that had both full behavioural test measures and L-CAT scores were included in the analysis.

5.1.2.2 Statistical methods:

It was hypothesised that L-CAT cluster scores would be predictive of the behaviour measure clusters with which they were hypothesised to share similar underpinning core processes of interest (i.e. SEEKING, FEAR and RAGE). Thus a high L-CAT RAGE cluster score (sRQ) would be expected to be predictive of a high behaviour cluster RAGE score (sRB) etc. To test for the predictive relationship between L-CAT and behaviour cluster scores, data were analysed using Generalised Linear Mixed Effects models (GLMMs) with behaviour cluster scores used as the response variable in each model. This approach allows the nature of the relationship between the different types of measures to be assessed (i.e. facilitates the assessment of convergent and thus construct validity), with the potential aim being to be able to use only the measures (individually or in combination) which provide the most useful and valid sources of information, whilst also being as practical as possible.

Both cat identity *and* rehoming centre were included as random effects within statistical models. In this way, potential relationships between behavioural measures and questionnaire data could be assessed without the presence of these potential confounds. Whilst the original scale questionnaire item scores were ordinal, generating composite cluster scores allowed these variables to be classed as continuous data. Data were analysed using GLMMs with Poisson error structures from the package ‘lme4’ (Bates 2007). This method was preferable to regression mixed models where the presence of two random effects is not currently supported. Models were simplified using maximum likelihood fits, by the process of step-wise elimination of the least significant effects to produce the Minimum Adequate Models (MAMs) (Crawley 2007). Model diagnostics were performed to assess normality, heteroscedasticity and check for overdispersion.

All analyses were carried out in R software (version 3.1.0) (R Development Core Team, 2014).

5.1.3 Results: (See Table 5.3 for statistical summaries).

Behaviour Cluster 1 (Social RAGE):

Higher social RAGE behaviour scores (sRB) were associated with higher social SEEKING (sSQ) and social RAGE (sRQ) L-CAT scores (as an interaction), however as individual factors, higher RAGE sRB behaviour scores were associated with *lower* social SEEKING (sSQ) and *lower* social RAGE (sRQ) L-CAT scores.

Behaviour Cluster 3 (Social SEEKING):

Higher social SEEKING behaviour scores (sSB) were associated with lower social FEAR L-CAT scores (sFQ), but were not associated with social SEEKING (sSQ) or RAGE (sRQ) scores.

Table 5.3 Summary of the significant relationships between L-CAT and Behaviour cluster scores. Statistical results taken from GLMM X^2 tests, using stepwise elimination of non-significant factors. Test statistics for factors retained within the Minimum Adequate Models (MAM's) only are reported. For the 'direction of effects', test statistics are taken from summary outputs of the MAMs.

Cluster:	L-CAT Cluster sSQ (social SEEKING)	L-CAT Cluster sRQ (social RAGE)	L-CAT Cluster sFQ (social FEAR)	Statistical effects found:	Direction of effects:
Behaviour Cluster **sRB** (Social RAGE)	**x**	**x**		Cluster sSQ: Cluster sRQ (n= 88, X^2=6339, df= 1, P<0.05*)	Cats that had both higher Cluster sSQ and sRQ scores (as an interaction) meowed significantly *more* (n=88, estimate= 0.20017, standard error = 0.08681, Z =2.306, p<0.05*). However (as individual factors) cats with *lower* cluster sSQ scores also meowed significantly more (n=88, estimate = 0.69545, standard error = 0.33667, Z= 2.066, p<0.05*), as did cats with lower Cluster sRQ scores (Estimate= 2.81980, standard error = 1.18894, z= 2.372, p<0.05*).
Behaviour Cluster **s/pSB** (social or physical SEEKING)			x	Cluster sSQ (n= 88, X^2= 6.4041, df=1, p<0.05*)	Cat with lower Cluster sFQ scores approached people significantly more (n=88, estimate= 0.15156 , standard error= 0.06014 Z = 2.520, p<0.05*).

5.1.4 Discussion:

The relationship between two different types of measures developed using the same underpinning theoretical framework were assessed. Results indicated that cats that were rated highly on the L-CAT by staff for both social RAGE (sRQ) and social SEEKING (sSQ), also scored highly for social RAGE (sRB) in the behavioural tests (i.e. they meowed significantly more often). The finding that potential behavioural signs of frustration in the test context were related to general levels of RAGE and SEEKING combined in a daily context (i.e. staff impressions) makes sense given that; (i) the meow is considered to be a socially reinforced behaviour (e.g. see Nicastro 2004, Yeon *et al* 2011, Schötz and van de Weijer 2014), and thus is indicative of a level of prior social experience with people, as well as the desire to communicate with people, and that (ii) meows within the given test context were hypothesised to be indicative of social RAGE reactivity in particular (see Table 2.12, Chapter 2).

However, the results indicated that if cats received a *low* rating for either sRQ or sSQ on the L-CAT, they also scored significantly higher for social RAGE (sRB) in the behaviour tests (i.e. they meowed more). Such results would suggest that the relationship between the behaviour and questionnaire measures is complex, and that the function and/or affective qualities of vocalisations within the test context may vary depending upon other factors. For example, the vocalisations emitted by a cat that is high in social SEEKING (sSQ) and social RAGE (sRQ) may be indicative of social frustration/RAGE (i.e. the cat is motivated to seek out human interaction but also becomes frustrated during such interactions), as are those emitted by a cat that is low in social SEEKING (sSQ) (who finds being in close proximity with a person (that in two of the three behaviour test conditions was attempting to encourage interaction with the cat – i.e. behaving actively) aversive and frustrating). On the other hand, vocalisations emitted by a cat that is low in social RAGE (sRQ) could be less RAGE related, and instead serve a care soliciting function (e.g. see Crowell-Davis *et al* 2004, Brown & Bradshaw 2013). Thus vocalisation alone is not discriminatory.

Because there is evidence to suggest that vocalisations such as both the meow and purr may vary qualitatively based on affect and/or context (Nicastro and Owren 2003, McComb *et al* 2009, Yeon *et al* 2011, Schötz and van de Weijer 2014), it is possible that the vocalisations emitted by cats that had both high sSQ and sRQ or low sSQ scores (i.e. the vocalisations hypothesised to be RAGE based) could have similar acoustic qualities but be different to those emitted by cats that had low sRQ scores (i.e. those hypothesised to perform a care-soliciting function). This hypothesis deserves further investigation.

With regards to the social/physical SEEKING behaviour cluster (s/pSB), higher scores were associated with lower L-CAT ratings for social FEAR (sFQ), which is also consistent with the hypothesis that highly fearful cats may be less likely to approach people within an unfamiliar environment. However, the finding that s/pSB scores were *not* significantly related to staff ratings of social SEEKING (sSQ) as might be expected, may suggest that this cluster of behaviour measures may be more representative of the SEEKING of physical rather than social stimuli, or that the context may vary between individuals. Again, more detailed qualitative behavioural information could help to identify potential affect-based differences in behavioural outputs that may vary between contexts. For example there is evidence to suggest that both the lateralisation of movements (Pierce *et al* 2000, Mazzotti and Boere 2009) as well as certain facial muscle changes (Parr *et al* 2007a&b) could provide useful information in relation to the social and/or emotional aspects of a particular context. Such information could thus potentially be used in conjunction with the current test measures in order to increase their sensitivity and specificity in relation to the identification of underpinning emotional activation and its social/physical nature.

5.1.5 Conclusion:

At present, such non-uniformity in the relationship between behavioural and questionnaire items within the test population highlights the difficulty in using simple or gross types of behavioural measures in the assessment of underlying temperament, because similar behavioural responses may relate to very different motivational/affective states depending upon the individual and context, thus making their precise interpretation difficult without the addition of further detailed/qualitative information. A similar issue was highlighted in Chapter 3 where the behavioural test measures were found to be differentially affected by social factors across locations/environments. Such results would ultimately suggest that particularly when used independently, these types of behavioural measures may be greatly limited in their ability to provide reliable information in relation to specific emotional activation and the relevant underpinning traits of interest.

5.2 Part (2): Assessing the relationship between the presence of handling issues and L-CAT scores.

5.2.1 Introduction:

In the second part of this chapter, the significance of the presence of issues when cats were handled for placement into the carrier prior to the Emergence test (Test 3) was assessed in relation to their predictive relationship with L-CAT scores. The nature of the Emergence tests (Test 3) required cats to be sufficiently ‘handleable’ for four consecutive days in order to collect necessary behavioural measures to produce the cluster scores. However, such a process may potentially have excluded cats that could have been the *least* sociable and had the *highest* FEAR and/or RAGE reactivity from being represented with the test population. It was therefore important that L-CAT scores were assessed in relation to initial 'handleability' in addition to actual behavioural test scores.

5.2.2 Methods:

5.2.2.1 Data analysis and statistical methods:

A total of 104 individuals across the three rehoming centres (BDCH, MHW and WG) with no missing relevant L-CAT items were identified. Within this population, a total of 88 cats also received the full suite of behavioural tests, with 16 cats having missed one or more test conditions due to the presence of handling issues (HI) on a particular day. HI’s were as previously defined in Chapter 2 where ‘the cat could not be safely and calmly placed in the carrier (for example they attempted to bite or swipe the handler with claws unsheathed)’.

Unfortunately, the repeatability and thus reliability of the presence of HI could not be determined prior to the current analysis because not enough cats within the test-retest population displayed HI on their first test to facilitate meaningful statistical analysis.

The presence of HI was thus assessed in relation to its predictive relationship with L-CAT cluster scores (sSQ, sRQ, sFQ, see Table 4.5, Chapter 4) (assessed both individually and as interactions) using Generalised Linear Mixed Effects models (GLMMs) with Poisson error structures from the package ‘lme4’ (Bates 2007). Cat identity and centre location were again treated as random effects within the models. Models were simplified using maximum likelihood fits, by the process of step-wise elimination of the least significant effects to produce the Minimum Adequate Models (MAMs) (Crawley 2007). Model diagnostics were performed to assess normality, heteroscedasticity and check for overdispersion.

All analyses were carried out in R software (version 3.1.1) (R Development Core Team, 2014).

5.2.3 Results:

Cats with no recorded HI had significantly higher social SEEKING (sSQ) cluster scores, (n= 104, Estimate=0.22236, standard error=0.07881, Z= 2.82, $p<0.001$) and significantly lower social RAGE (sRQ) cluster scores (Estimate= -0.3540, standard error= 0.1199, Z= -2.952, $p<0.001$). There were no significant interactions between multiple clusters and no significant relationship was found between HI and social FEAR (sFQ) scores (all $p>0.05$).

5.2.4 Discussion:

Results of the mixed effects models indicated that cats that could not be placed calmly and safely in to a carrier were likely to be scored lower for L-CAT clusters hypothesised to relate to social SEEKING (sSQ) and higher for those relating to social RAGE (sRQ), but not higher for FEAR (sFQ) (as might also have been expected). The fact that higher RAGE cluster scores were associated with an aggressive or otherwise aversive response to human handling would support the convergent validity of the different measures in relation to the assessment of this core emotional process.

Whilst relative ‘handleability’ of an individual might be of predictive value in the assessment of human-sociability and propensity to aggress, it may be less useful in the assessment of fearfulness. Such results would instead support the hypothesis that fearfulness (at relatively lower levels of intensity) is potentially better characterised by the absence of specific behavioural responses rather than their presence, due to the inhibitory or ‘freezing’ effects arousal of the fear circuitry may have upon certain behaviours (see Panksepp 1988, Fanselow 1994, De Oca *et al* 1998). Therefore during handling, fearful individuals may be more likely to remain still or freeze rather than try to escape or behave aggressively. In line with previous theory and evidence from Electrical Stimulation of the Brain (ESB) research (see Panksepp 1998), such results may also suggest that the manifestation of an aggressive response is primarily triggered by activation of RAGE rather than fear FEAR circuitry.

Such information may have important implications in relation to staff assessments where cats may be predominantly assessed in relation to their response to handling, and as a consequence those that are fearful could go undetected. Indeed, research by McCune (1994) found that during a period of being caged, staff were more likely to identify the less inhibited and more active cats as being of greatest welfare concern, even though cats that were inactive and inhibited were potentially much more distressed, taking longer to habituate.

Therefore if ‘handleability’ were used solely as a predictive measure, the issue of test specificity is relevant and further detailed behavioural information at the time of handling may be necessary in order to differentiate cats that are easier to handle because they are relatively sociable and do not have a tendency to aggress, from those that are easy to handle but primarily because they are fearful and as such are inhibiting certain behavioural responses. It is thus suggested that if such a measure is to be used, it is done so in combination with others (such as the L-CAT).

5.2.5 General conclusion:

5.2.5.1 Convergent validity of L-CAT and behavioural measures:

Results would indicate a level of convergent validity between high social SEEKING (sSQ) and social RAGE (sRQ) L-CAT scores, and social RAGE behaviour test scores (sRB), however the relationship between such variables was not consistent, and varied depending upon the relative contributions from the L-CAT clusters (i.e. whether they were high or low or viewed independently or as interactions changed the nature of their relationship with the behaviour scores).

On the other hand, a good level of convergent validity (as well as homogeneity) was demonstrated between the absence of Handling Issues (HI), and higher social SEEKING (sSQ) and lower social RAGE (sRQ) L-CAT scores, which in combination may provide a more reliable approach to the identification of SEEKING and RAGE (in social contexts) than combinations of the L-CAT and behavioural test measures (i.e. sRB and s/pSB).

Because the final behaviour test model did not contain measures specifically hypothesised to relate to FEAR, the convergent validity of questionnaire measures with behavioural ones in relation to this emotional process that *could* be demonstrated was ultimately limited. However the fact that cats with lower social FEAR (sFQ) scores had higher social/physical SEEKING behaviour test scores (s/pSB) would (indirectly) lend support to the validity of this construct because only cats low in social fear would be expected to approach people in the context of the behavioural test.

Whilst HI would appear to offer a more consistent source of evidence of convergent validity in support of the L-CAT measure constructs (i.e. social FEAR, SEEKING and RAGE), due to practical reasons its reliability could not be established during Experiment 2 (Chapter 3). Additionally, HI was always performed amongst a series of other test manipulations during the four day test period, and thus its potential independent contribution as a predictive measure is also unknown. It is thus suggested that the L-CAT items currently offer the most reliable, valid and practical method of assessment in relation to aspects of the core emotional processes of interest.

5.2.5.2 Example of the application of L-CAT cluster scores in the 'profiling' of individuals based on their potential combinations:

Six potentially important provisional profiles based on various combinations of relevant L-CAT (sSQ, sRQ, and sFQ) cluster scores are presented.

(i) Cats high in social SEEKING (i.e. Human-sociability) but low in social RAGE (i.e. Human-directed frustration) and also social FEAR (i.e. fearfulness towards humans). These cats may have higher sSQ and lower sRQ sFQ scores.

(ii) Cats high in social SEEKING but also social RAGE. These cats may have higher sSQ and sRQ scores.

(iii) Cats high in social SEEKING but also high in social FEAR. These cats may have high sSQ and sFQ scores.

(iv) Cats low in social SEEKING but high in social RAGE. These cats may have lower sSQ and higher sRQ scores.

(v) Cats low in social SEEKING and also low in social RAGE and social FEAR. These cats may have lower sSQ, sRQ and sFQ scores.

(vi) Cats low in social SEEKING but high in social FEAR. These cats may have lower sSQ scores and high sFQ scores.

*S*uch assessments could provide information about the potential behavioural tendencies of cats within the rehoming centre and may help determine how these types of individuals may be optimally managed and handled within such an environment, and additionally which cats may or may not be suitable to be entered in to the general rehoming population. However, in order to determine whether such measures relate to the behaviour of the cat post-adoption, their predictive validity in relation to future behaviour must also be assessed.

5.2.5.3 Main findings and questions raised:

- The results of this chapter suggest a good level of convergent validity between measures within the L-CAT and the response of cats towards human handling. However, a heterogeneous relationship between the L-CAT and behavioural test measures further indicate the limitations associated with the use of these types of measures in the assessment of behavioural tendency.

- Combinations of the three L-CAT scores could be used to assign individual profiles to cats, enabling a more individual specific approach to their management within the rehoming environment.

6 Chapter 6 - Assessing the stability and predictive validity of reliable assessment measures (L-CAT and behavioural test) in relation to adopter reported behaviour and satisfaction post-adoption

6.0 Introduction

Within this chapter, the stability as well as predictive validity of the information generated from cats within the rehoming environment using the current models (i.e. Behavioural test and L-CAT measures) were assessed in relation to future behaviour within the home. As with various other temperament tests (such as those carried out in domestic dogs, e.g. Netto and Planta1997, van den Berg *et al*. 2003, Svartberg 2005) the external criterion for the assessment of predictive validity of the model was based on adopter reports of behaviour, in this case, in the form of an adapted QA1 questionnaire, (QA.3).

6.0.1 Predictive validity

For any type of behavioural assessment that is designed to be used in one context (e.g. a rehoming centre) with the expectation that it will be able to predict future behavioural outcomes within another (e.g. the home), determining the predictive validity of such measures is crucial (e.g. see Messick 1995, Taylor and Mills 2006).

In this regard, many of the general personality tests previously developed for use in domestic cats are limited because where aspects of validity have been assessed, it has mostly been considered in relation to the convergent validity (e.g. see Feaver, *et al* 1986, McCune 1995), inter-observer reliability, (e.g. Turner *et al* 1986), or temporal stability of measures (e.g. Meier and Turner 1985, Lowe and Bradshaw 2001) within a specific context, rather than their future predictive validity in relation to an external criterion. In regards to assessments that have been designed intentionally for use in the rehoming environment, again, the predictive validity of measures in relation to future behaviour has not been specifically assessed (e.g. see Siegford *et al* 2003, Slater *et al* 2013a&c).

Within the current study, it was thus important that the reliable measures developed within the rehoming environment were assessed for their predictive validity in relation to future behaviour post-adoption. This involved the assessment of the context-stability of individual L-CAT items in relation to specific behavioural responses (i.e. from rehoming centre to home), and in addition the predictive validity of the reliable latent measure constructs (i.e. the clusters of measures), both in relation to adopter-reported behaviour (also at a latent construct level) and adopter post-adoption ‘satisfaction’.

6.0.2 Study aims for Part 1 and Part 2:

The aims of this chapter were;

- Part 1: To assess the individual stability of L-CAT items from rehoming centre (i.e. QA.1 items) to home (i.e. QA.3 items)

- Part 2: To use these stable items in combination with the refined Behavioural test model clusters (i.e. Model #4) in order to assess their predictive validity in relation to owner reported behaviour and post adoption satisfaction (based on QA.3 composite scores)

6.1 Part (1): Stability of L-CAT items from rehoming centre to home.

6.1.1 Methods:

6.1.1.1 Questionnaire development and data collection

6.1.1.1.1 Item content:

A further questionnaire (QA.3) was adapted from the original QA.1 questionnaire so that items were more applicable to new owners/adopters. Whilst item content was largely consistent, questions were re-worded slightly (for example ‘this cat’ was changed to ‘my cat’). The greatest deviation in questions from QA.1 to QA.3 was question q28; ‘The temperament and behavioural style of this cat will make it is easy to rehome’ this was changed to ‘I have considered rehoming this cat to someone else or returning this cat to the place of adoption’. Several additional questions were added to QA.3 which were relevant to the assessment of owner satisfaction of the cat (see Part 2 of this chapter). See also appendix 6.1 and 6.2 for an example of questionnaire QA.3 format and a summary of each question in relation to the underpinning core emotional processes and relevant traits).

6.1.1.1.2 Respondent demographics:

Questionnaire QA.3 was designed to be completed by the new adopter of the cat, shortly after adoption. This was the person identified as the primary carer for the cat at the time of adoption and was always 18 years of age or older.

6.1.1.2 Data collection:

Questionnaires QA.1 (staff) and QA.3 (adopter) were sampled across the four rehoming centres (BDCH, MHW, WG and CP). Where individuals had multiple QA.1 questionnaires filled out by staff, item ratings from the first QA.1 were used (excluding CP, this was usually the one completed by the staff member that was also present in the behavioural tests).

For Questionnaire QA.3, data was collected as follows: prior to the selection and rehoming of a cat, adopters were presented with a form containing a brief outline of the research project, and were given the option to participate in the study and fill in follow-up questionnaires about their cat's behaviour. Where adopters gave consent, they were either posted or emailed (depending upon their indicated preference) a copy of questionnaire QA.3 a week after the day of adoption.

6.1.1.3 Statistical analysis:

Inter-rater reliability for the refined items previously identified in Chapter 4 (i.e. items within the L-CAT, See Table 4.4) was assessed by extracting the Intra Class Correlation Coefficients (ICC) for each individual questionnaire item filled in by both rehoming staff (QA.1) and the new owner (QA.3). Because the two questionnaires were rated by different people, each 'rater' was viewed as a random effect within the test, and as such ICC2 'A random sample of k judges rate each target' (Revelle 2014, *taken from* Shrout and Fleiss 1979)) coefficients were extracted. ICC's were calculated using the *ICC* command from the *psych* package (Revelle 2014). For each ICC test, alpha was set at 0.05.

Prior to analysis, individual QA.3 items were checked to ensure that response rates were 90% or greater. For each item analysed, data was only included where cats had scores for both QA.1 and QA.3 items (i.e. there were no missing values, 'Unsures' or 'n/a's). Thus the sample size for each item analysed varied slightly from 79-89 (sample sizes for each item are given in Table 6.2).

6.1.2 Results:

Of the ten L-CAT items, six of these (to be referred to as the (refined) L-CAT) were significantly consistent with owner ratings in the home post-adoption. Of the unreliable items, several of these were hypothesised to be related specifically to social RAGE (e.g. whether the person avoids the cat due to potential aggressive behaviour, and whether the cat seems angry). Of the remaining reliable items, two were related to aspects of social SEEKING with an absence of FEAR (i.e. gregariousness - sociability and boldness: 'My cat likes being stroked' and 'My cat is friendly'). Another three of the items related to aspects of social FEAR (i.e. fearfulness), these were 'My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks', 'My cat is timid' and 'My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it', with this final item potentially also relating to aspects of social RAGE (i.e. human-directed frustration reactivity). The final item related to general behavioural stability of human-directed behaviour. (See Table 6.1 and Table 6.2 for a summary of the results).

Table 6.1 Summary of repeatability results from the Interclass correlation coefficients (ICC) performed on questionnaire QA.1and QA.3 items. Results in bold indicate a significant level of repeatability.

	Full question	N=number of cats sampled / Intraclass Correlation Coefficient for Intra-rater repeatability (ICC2):	F value / Degrees of freedom:	P value / confidence intervals
2)	**This/my cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:**	**N=85 ICC2= 0.47**	**F=1.9 Df=84,84**	**P<0.01* CI=0.177,0.65**
5)	**This/my cat is timid:**	**N=89 ICC2= 0.23**	**F=1.6 Df=88,88**	**P<0.05* CI= 0.021,0.41**
7)	This/my cat is vocal around people:	N=79 ICC2= 0.024	F=1.1 Df=78,78	P>0.05 CI= -0.16, 0.22
9)	**This/my cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it:**	**N=88 ICC2= 0.26**	**F=1.7 Df=87,87**	**P<0.01* CI= 0.058, 0.45**
16)	**This/my cat likes being stroked:**	**N=85 ICC2= 0.39**	**F=2.5 Df=84,84**	**P<0.0001*** CI= 0.17,0.56**
19)	I have avoided stroking this/my cat because I think it will behave	N=87 ICC2= 0.105	F=1.3 Df=86,86	P>0.05 CI= -

	aggressively towards me (i.e. growl, hiss, bite, swipe with claws):			0.089,0.30
20)	When I am around this/my cat, it seems angry :	N=86 ICC2= -0.0060	F=0.99 Df= 85,85	P>0.05 CI= - 0.20,0.19
23)	**This/my cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly):**	**N=82 ICC2= 0.28**	**F=1.8 Df=81,81**	**P<0.01* CI= 0.075,0.47**
26)	**This/my cat is friendly:**	**N=85 ICC2= 0.267**	**F=1.5 Df=84,84**	**P<0.05* CI= - 0.070,0.51**
28)	The temperament and behavioural style of this cat will make it is easy to rehome (staff)/ I have considered rehoming this cat to someone else or returning this cat to the place of adoption (adopters) (item reversed)	N=84 ICC2= 0.0071	F=1.04 Df=83,83	P>0.05 CI= - 0.058,0.094

Table 6.2 Summary of the (refined) L-CAT items – the repeatable items from the initial L-CAT model (Table 6.1), mapped against specific behavioural traits, their hypothesised relationship to underpinning emotional processes (marked with an ‘X’) and whether they involve social elements (s) (i.e. in relation to the human in an interactive capacity), or physical elements (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

Repeatable QA.3 (adopter) items	**Sociability (social) SEEKING**	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social/physical) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability**
2) My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks				**X(S)**		**X(S)**		
5) My cat is timid				**X(S,P)**				
9) My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it				**X(S)**	**X(S)**	**X(S)**		

16) My cat likes being stroked	**X(S)**	**X(S)**	**X(S)**					
23) My cat has changed in the way it interacts with me since I first adopted it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)								**X**
26) My cat is friendly	**X(S)**	**X(S)**	**X(S)**					

6.1.3 Discussion:

Of the ten L-CAT items assessed, six were found to be reliable not only within the rehoming centre, but also *between* the rehoming centre and the home. These elements of behaviour (as rated by people) were therefore considered to be particularly robust, providing a practical source of reliable information in relation to the behaviour of the cat. Interestingly, three of these six measures related specifically to how the cat responds during physical handling, suggesting that such aspects of cat-human interactions may be among the more stable features across environmental and temporal gradients.

In its application, the (refined) L-CAT could be used by rehoming staff to provide potential adopters with an idea about how they may expect the cat to behave in relation to these specific behavioural elements (i.e. managing adopter expectations), but may also help staff decide which type of environment they think may be most suitable for the cat. For example, many owners may want to be able to regularly stroke their cat, and if rehoming staff are able to reliably predict how the cat is likely to respond in such situations within the home (i.e. does the cat enjoy, avoid or behave aggressively – see questions 2, 6 and 16 of Table 6.2), this may prove very useful for the initial rehoming/cat-owner matching process.

Several of the items relating to social RAGE that were repeatable in the centre were not however repeatable when assessed by owners in the home. This might suggest that although owners may be able to recognise social SEEKING and FEAR within cats, they are less good at recognising social RAGE (frustration). Alternatively, it could be that the frustration exhibited by cats in the rehoming centre was predominantly a context-specific response. Due to the higher degree of physical and social confinement cats may experience in the rehoming centre compared with their environment post adoption, it is possible that RAGE activation occurred at a greater intensity within this initial context. It is also possible that the FEAR system may generally be more active than the RAGE system during initial exposure to the novel post-adoption environment, as at less intense levels of arousal, it is thought that the

RAGE and FEAR systems may have mutually inhibitory effects depending upon the context (Panksepp 1998).

It may thus be the case that in relation to the prediction of human-directed aggression, it can only be reliably determined by questionnaire in relation to incidences specific to the cat being stroked (i.e. item 9 of QA.3), rather than the more general trait-construct of frustration reactivity and underpinning emotional process (RAGE), or to behavioural manifestations of RAGE in non-social contexts. It is possible however that the use of a combination of latent-scale measures (i.e. both Behavioural test and the clusters of (refined) L-CAT items) may prove a more broadly predictive tool in this regard, because such measures may ultimately better represent the identified key traits and underpinning emotional process in a more context-general way.

6.2 Part (2): Predictive validity of behavioural and L-CAT cluster measures in the rehoming centre in relation to adopter ratings and also 'satisfaction' post adoption.

6.2.1 Introduction:

In part 2, the predictive validity of the (refined) L-CAT and behavioural cluster measures (both individually and as interactions) were assessed in relation to future behaviour (e.g. see Ledger 1991, Duffy and Serpell 2012, Foyer *et al* 2014), in this case within the home environment. Because relative owner 'satisfaction' may affect not only the quality of the cat-owner relationship (e.g. Serpell 1996, Adamelli *et al* 2005, Curb *et al* 2013) but also the general 'homeability' of individuals (Wells and Hepper 2000, Kwan *et al* 2013), the clusters were also assessed for their ability to predict how 'satisfied' owners felt with their cats post adoption.

Ideally such assessments would have been performed on the measures that were found to demonstrate the best level of content, convergent and thus construct validity (i.e. L-CAT scores *and* Handling Issues (HI), see Chapter 5). However, because the population of cats that presented HI was substantially smaller than the main test population (only 16 out of 88 cats), not enough post-rehoming data was available on such cats for HI to be included as a potential predictive factor in the analysis (data from only two cats was available). Thus the assessment of predictive validity of rehoming centre measures in relation to adopter reported behaviour was performed on the (refined) L-CAT scores and the Behaviour test measures.

For this analysis, the use of composite measures (latent scale variables) (i.e. L-CAT and Behaviour test cluster scores) were preferred because when taken collectively, contributions from multiple individual items may better describe the underlying constructs of interest (i.e.

the separate core emotional processes) and also facilitate practical statistical analysis whilst maintaining as much behavioural information as possible. Such measures can also be directly assessed in relation to other latent scale measures (i.e. latent measures created from QA.3 data) that may not share identical individual components, but that share the same theoretical underpinnings. Therefore it was initially necessary to generate new clusters based on the six (refined) L-CAT items that previously demonstrated sufficient stability between the rehoming centre and the home (i.e. those identified in Part 1 of this chapter). Such clusters could then be assessed alongside the behavioural measures to determine their predictive relationship with similar types of constructs (i.e. those with shared theoretical links to the core emotional processes) created from the questionnaire based on adopter reports of behaviour (QA.3).

It was thus also necessary to establish the longitudinal reliability of individual QA.3 items prior to analysis. For this, a stable population of established cat owners were surveyed over two separate time points (with a gap of about six months in between) using the Questionnaire A.3 format, so that items could be assessed individually for their repeatability/stability within the home before then being analysed in the rehoming centre/adopter population.

6.2.2 Methods:

6.2.2.1 Data collection and analysis:

6.2.2.1.1 Adopter satisfaction:

In addition to the items that were matched to reflect those in the QA.1 (staff) questionnaire, the QA.3 (adopter) questionnaire also contained four items that were aimed at gauging 'owner/adopter satisfaction'. These were the following items: 'This cat has met all my expectations', 'I feel my cat is happy living with me', 'I am happy with my cat' and 'I have considered rehoming this cat to someone else or returning this cat to the place of adoption' (see appendix 6.1 for an example of the full questionnaire format). Cat relinquishment appeared extremely low within the test population even six months post adoption (only one person that provided QA.3 follow up information disclosed that they had relinquished their cat), and thus ‘owner satisfaction’ provided an alternative means of predicting the potential ‘homeability’ or ‘suitability’ of cats in relation to the assessments carried out in the rehoming centre, rather than relinquishments.

6.2.2.1.2 L-CAT Clusters based on (refined) items:

The same method of data reduction (Hierarchal Cluster Analysis (HCA)) as used in previous chapters was performed on the remaining six items identified in Part 1 of this chapter in order to generate new clusters of items based on reliable measures only.

6.2.2.1.3 Longitudinal reliability of QA.3 (Cat owner population) items:

In order to gather data from a stable population of cat owners, an online version of questionnaire QA.3 was launched (referred to as ‘Cat Owner Survey’). Anyone that owned a cat was eligible to complete the survey, and each participant was asked to fill in the questionnaire for one cat (if owning several cats, they were instructed to choose the cat that they felt they knew the best). Owners were required to provide their email addresses at the end of the first questionnaire and were then emailed approximately six months after completion of the first survey, to ask if they would be willing to fill in a second QA.3 about the same cat. First and second surveys for each cat owner were then matched and data extracted so that the intra-rater reliability of individual items could be assessed. For each item, only cats with scores for both the first and second QA.3 were included, thus sample sizes varied slightly (from 518-544). Prior to analysis, individual items that had a response rate of <90% (i.e. 11% or more of the items were either marked as ‘unsure’ or ‘n/a’ or were left blank) were excluded.

6.2.2.1.4 Data reduction of QA.3 (Cat adopter population) items:

All items that demonstrated sufficient longitudinal reliability in the online 'Cat Owner' Survey were then analysed in the cat-adoption population.

In order to provide an effective means for statistical comparisons and to identify and remove any unnecessary or redundant measures, data reduction techniques were performed so that smaller numbers of latent variables could be created from the initial large amount of items in QA.3. Data across the four separate centres were pooled with a total of 244 questionnaires being included in the analysis (12 from MHW, 14 from CP, 46 from WG and172 from BDCH).

Data were analysed using polychoric exploratory Factor Analysis (FA), which unlike Pearson's correlations (the most commonly used type of FA) does not assume that variables are quantitative and measured in intervals or that their relationship is monotonicit, and as such is argued to provide a better model in the analysis of Likert-scaled ordinal data (Holgado–Tello *et al* 2010). Again, prior to analysis, individual questionnaire items that had a response rate of <90% were excluded. Individuals with missing scores for any of the items were also removed. To ease the interpretation of factor outputs, a high score always indicated high agreement with the question.

Items hypothesised to relate to owner/adopter satisfaction were analysed alongside the other behaviour-specific items. This enabled the assessment of their convergent validity in relation to their suitability in representing the construct of 'satisfaction' (i.e. whether the four individual items loaded strongly on the same factor or not). Such an approach also allowed the strength of loadings of other behaviour-specific items to be assessed in relation to 'satisfaction' items, potentially indicating those that may be most closely linked.

Item reduction was determined following a process similar to that used by Sheppard and Mills (2002). Several sequential FA's were run, each time items with loadings of <0.40 were removed until all remaining items in the refined set loaded (either positively or negatively) at 0.40 or above on at least one of the factors produced. Each time items were deleted, the structure of the remaining factors and their loadings were assessed to ensure this remained stable. In order to determine whether additional measures could be removed from the final data set, where several items loaded similarly across one or more of the same factors in the final refined FA, a correlation matrix of items was used to check for high item-item correlations (which would suggest that such items were in essence acting as duplicates). The means and standard deviations of each of the remaining items were then compared to rule out the possibility that similar item loadings were an artefact of their shared response levels (i.e. all very highly or lowly scored items load together), (see Bernstein 1988). Factors were then interpreted in relation to hypothesised underpinning emotional processes.

6.2.2.1.5 Predictive relationship between refined rehoming centre measures and adopter reported behaviour:

QA.3 factors generated with the remaining items were then used in order to produce individual factor scores for each cat that had both a QA.1 and QA.3 with no missing items (see appendix 6.3). To initially maintain the original variation within the data set, factor scores for each individual were generated using a simple 'sum scores' approach (DiStefano and Mindrila 2009). Whilst for ease of the Factor loading interpretations, higher loading scores always represented the highest level of agreement with the question item, when generating factor scores for individuals, some scales were reversed so that a high factor score would then represent a high level of SEEKING, FEAR, handling tolerance etc., avoiding negative score values and aiding in the interpretation of the statistical model outputs. Both Behavioural measure and (refined) L-CAT cluster scores were then assessed for their predictive relationship with the QA.3 factor scores generated from the 'Cat adopter' questionnaire.

6.2.2.1.6 Predictive relationship between refined rehoming centre measures and adopter satisfaction:

Both behavioural measure and refined L-CAT cluster scores were assessed (individually and in combination) for their predictive relationship with owner 'satisfaction' factor scores generated from the QA.3 data. In addition to the cluster scores, the six individual L-CAT items were also assessed in relation to owner 'satisfaction'.

6.2.2.2 Statistical methods:

All analyses were carried out in R software (version 3.1.0) (R Development Core Team, 2014).

6.2.2.2.1 L-CAT Clusters based on refined reliable items:

A Hierarchical Cluster Analysis (HCA) and subsequent dendrograms were generated from the remaining six L-CAT items, using the *hclust* function from the *stats* package (R Core Team 2013) on the same data used to generate the previous L-CAT dendrogram (see Figure 4.1, Chapter 4). The new dendrogram was 'cut' at a place where several distinct clusters of measures could be identified (Clusters sSQ and sFQ, Figure 6.1), and their structure then compared to those within the previous dendrogram (Figure 4.1, Chapter 4).

6.2.2.2.2 Longitudinal reliability of QA.3 (Cat owner population) items:

Intra-rater reliability for each item was assessed by extracting the Intra Class Correlation Coefficients (ICC) for each item from the two questionnaires being compared (the first and second QA.3 filled in by the stable population of cat owners). Because items were filled in by the same individual, ICC3 ('A fixed set of k judges rate each target', (Revelle 2014, *taken from* Shrout and Fleiss 1979)) coefficients were extracted.

All ICC's were calculated using the *ICC* command from the *psych* package (Revelle 2014). For each ICC test, alpha was set at 0.05.

6.2.2.2.3 Data reduction of QA.3 (Cat adopter population) items:

In order to determine how many factors to extract prior to each FA, polychoric parallel analysis and relevant scree plots were produced. Polychoric Factor Analysis with varimax rotation and associated correlation matrices were then generated using the *polychor* package (Fox 2010).

6.2.2.2.4 Predictive relationship between refined rehoming centre measures and adopter reported behaviour.

To test for the presence of a predictive relationship between the rehoming centre data (both (refined) L-CAT and Behaviour test cluster scores) and owner reported behaviour (via the use of Factor scores), data were analysed using Generalised linear mixed models (GLMMs) with Poisson error structures. Both individual identity of the cat and centre location were treated as random fixed effects within the models. Only data from cats that received the full battery of relevant behavioural tests, and also had a completed QA.1 (staff) and QA.3 (adopter) questionnaire were included in the analysis (*n=37*). Scales for the Behavioural and QA.1 cluster scores and also QA.3 behaviour factor scores varied depending upon the number of individual items they were comprised of as well as the nature of the measures, thus all composite scores were standardised via Z scoring prior to statistical analysis.

The package *lme4* (Bates 2007) was used for the mixed effects models. Models were simplified using maximum likelihood fits, by the process of step-wise elimination of the least significant effects to produce Minimum Adequate Models (MAMs) (Crawley 2007). Model diagnostics were performed to assess normality and check for heteroscedasticity and overdispersion.

6.2.2.2.5 Predictive relationship between refined rehoming centre measures and adopter satisfaction:

To assess the predictive relationship between rehoming centre measures and adopter satisfaction scores, a similar method and analysis process to the above was used.

6.2.3 Results:

6.2.3.1 L-CAT Clusters based on refined reliable items:

From the HCA dendrogram performed on the six (refined) L-CAT items, two distinct clusters of measures were identified (Clusters sSQ(r) and sFQ(r), Figure 6.1). With the removal of several items relating to social RAGE (i.e. those found to be unstable in Part (1), the social RAGE cluster (sRQ, Figure 4.1, Chapter 4) was no longer represented. The two remaining clusters however maintained a very similar structure to those in the previous ten item dendrogram (Figure 4.1, Chapter 4), and thus the original interpretation of such clusters in relation to their core process was maintained (e.g. sSQ – social SEEKING, and sFQ– social FEAR, see Table 6.3). An additional (r) at the end of each cluster was however used to denote the clusters have been formed using the (refined) version of the L-CAT items).

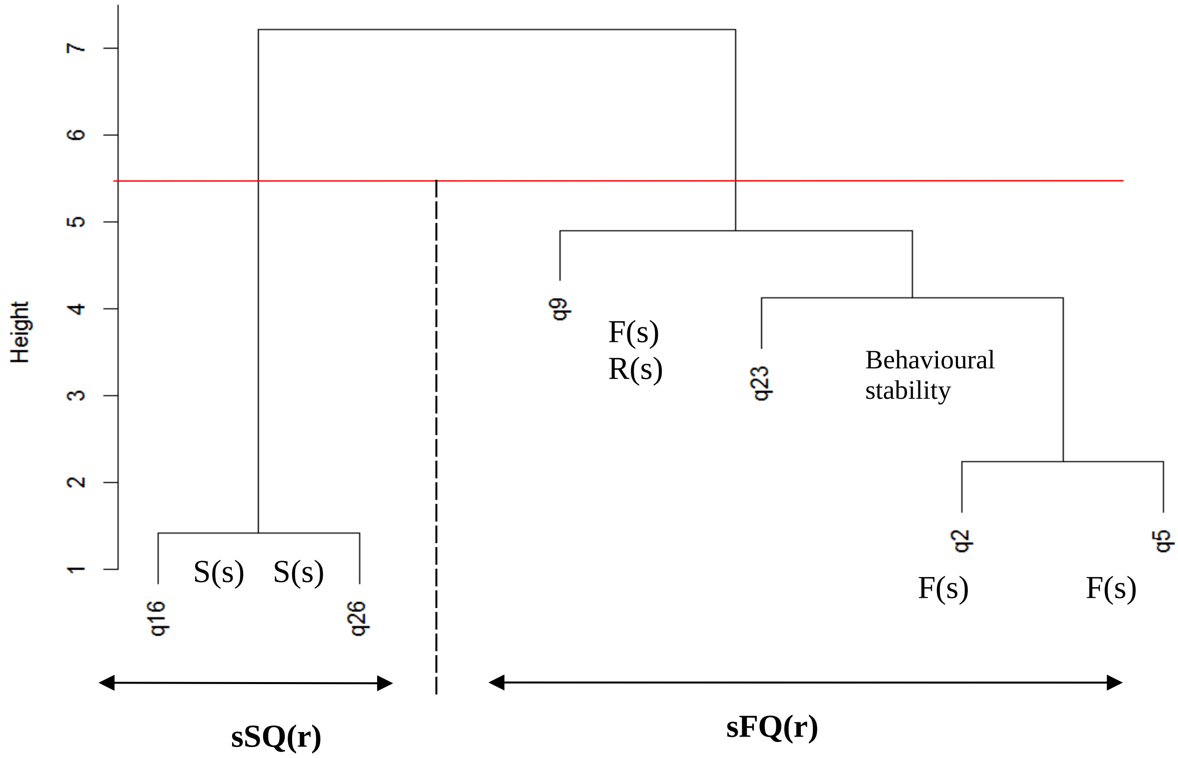

Figure 6.1 *(refined)* L-CAT Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on the six reliable questionnaire items as summarised in Table 6.2. Dendrogram of items was produced using average linkage between groups based on binary squared Euclidean distance matrix. Data from a population of 88 individual cats across four separate rehoming centres (BDCH, CP, MHW, WG) were included. The central vertical black dotted lines represent the two main clusters (sSQ(r) and sFQ(r)) that are apparent within the dendrogram, whilst the red horizontal line represents the height at which the dendrogram was 'cut' to create the separate clusters. Each individual item is represented in relation to the predicted primary emotional processes (and their context) of relevance (see also Table 6.2 and 6.3).

Table 6. 3 The six (refined) L-CAT items reliable between the rehoming environment and the home and their place within each cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. Cluster sSQ(r) contains questionnaire items that are hypothesised to represent social SEEKING and cluster sFQ(r) social FEAR.

Cluster sSQ(r)	**Emotional processes and context**	**Cluster sFQ(r)**	**Emotional processes and context**
Q16 This cat likes being stroked	S (s)	Q2 This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks	F (s)
Q26 This cat is friendly	S (s)	Q5 This cat is timid	F (s, p)
		Q9 This cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it	F(S) R(s)
		Q23 This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)	F (s) R (s)
Interpretation of each cluster:			
SEEKING (primarily a **social** context)		FEAR (primarily a **social** context)	

6.2.3.2 Longitudinal reliability of QA.3 items:

All items analysed from the stable online ‘Cat owner’ population were found to be significantly repeatable (see Table 6.4 below), thus all QA.3 items from the ‘Cat adopter’ population were considered suitable for inclusion in the subsequent Factor Analyses.

Table 6.4 Summary of repeatability results from the Interclass correlation coefficients (ICC) for the first and second QA.3 ('Cat Owner') online questionnaire items filled in by a stable population of cat owners.

QA.3 ('Cat owner') Questionnaire items	N=number of cats sampled ICC3 = Intraclass Correlation Coefficient for Intra-rater repeatability:	F value /Degrees of freedom:	P value /confidence intervals
1) My cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)	N=543 ICC3= 0.48	F=2.8 Df=542,542	P=<0.0001*** CI=0.41,0.54
2) My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks	N=543 ICC3=0.49	F=2.9 Df=542,542	P=<0.0001*** CI=0.42, 0.55
3) My cat is comfortable being picked up	N=0.72 ICC3=0.72	F=6.1 Df=539,539	P=<0.0001*** CI=0.68, 0.76
4) When I initiate contact or interaction with my cat, it doesn't move away but it is quiet and not very responsive towards me (i.e. it doesn't purr or rub up against me)	N=541 ICC3=0.44	F=2.6 Df=540,540	P=<0.0001*** CI=0.37, 0.51
5) My cat is timid	N=542 ICC3=0.66	F=4.9 Df=541,541	P=<0.0001*** CI=0.61, 0.71
6) My cat will come and say 'hello' and approach me (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss	N=538 ICC3=0.42	F=2.5 Df= 537,537	P=<0.0001*** CI=0.35, 0.49
7) My cat is vocal when around people	N=540 ICC3=0.64	F=4.5 Df=539,539	P=<0.0001*** CI=0.59, 0.69
8) My cat comes and asks me for attention and initiates contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/	N=543 ICC3=0.49	F=2.9 Df=542,542	P=<0.0001*** CI=0.42, 0.55

strokes/ chin/cheek tickles)			
QA.3 ('Cat owner') Questionnaire items	**N=number of cats sampled ICC3 = Intraclass Correlation Coefficient for Intra-rater repeatability:**	**F value /Degrees of freedom:**	**P value /confidence intervals**
9) My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it	N=542 ICC3=0.63	F= 4.3 Df=541,541	P=<0.0001*** CI=0.57, 0.67
10) My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I perform routine health procedures (such as grooming/ carrying out health checks, or when administering medication, etc.)	N=528 ICC3=0.62	F=4.3 Df=527,527	P=<0.0001*** CI=0.57, 0.67
11) My cat is keen to explore new things in its environment	N=538 ICC3=0.55	F=3.4 Df=537,537	P=<0.0001*** CI=0.48, 0.60
12) My cat is quick to settle and adapt to change	N=516 ICC3=0.55	F=3.4 Df=515,515	P=<0.0001*** CI=0.49, 0.61
13) My cat is playful	N=544 ICC3=0.57	F= 3.7 Df=543,543	P=<0.0001*** CI=0.51, 0.63
14) My cat gets carried away during play, which has led to me being bitten or swiped at	N=535 ICC3=0.61	F=4.1 Df=534,534	P=<0.0001*** CI=0.56, 0.66
15) My cat would prefer be left alone, rather than be with people	N=536 ICC3=0.58	F=3.7 Df=535,535	P=<0.0001*** CI=0.52, 0.63
16) My cat likes being stroked	N=544 ICC3=0.58	F=3.8 Df=543,543	P=<0.0001*** CI=0.52, 0.63
17) I avoid stroking or handling my cat because I feel that it doesn't want me to	N=537 ICC3=0.54	F=3.3 Df= 536,536	P=<0.00001*** CI=0.47, 0.59
18) My cat is very tolerant to being handled	N=539 ICC3=0.69	F=5.4 Df=538,538	P=<0.0001*** CI=0.64, 0.73
QA.3 ('Cat owner') Questionnaire	**N=number of**	**F value**	**P value**

items	cats sampled ICC3 = Intraclass Correlation Coefficient for Intra-rater repeatability:	/Degrees of freedom:	/confidence intervals
19) I avoid stroking my cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)	N=541 ICC3=0.59	F=3.9 Df= 540,540	P=<0.0001*** CI=0.53, 0.64
20) My cat seems angry around me	N=540 ICC3=0.45	F=2.6 Df=539 539	P=<0.0001*** CI=0.38, 0.51
21) If my cat could choose, it would prefer to have a bowl of food rather than interact with me	N=525 ICC3=0.61	F=4.1 Df=524,524	P=<0.0001*** CI= 0.55, 0.66
22) My cat is more keen to interact with and be near me when I have food/ treats	N=518 ICC3=0.51	F=3.1 Df= 517,517	P=<0.0001*** CI=0.44, 0.57
23) My cat has changed in the way it interacts with me since I first adopted it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)	N=530 ICC3=0.51	F=3.1 Df=529,529	P=<0.0001*** CI=0.45, 0.57
24) My cat behaves differently with strangers than it does with me	N=535 ICC3=0.56	F=3.5 Df=534,534	P=<0.0001*** CI=0.50, 0.61
25) My cat behaves differently with me than it does with other (human) members of the household	N=535 ICC3=0.56	F=3.5 Df=534,534	P=<0.0001*** CI=0.50, 0.61
26) My cat is friendly	N= 542 ICC3=0.68	F= 5.2 Df=541,541	P=<0.0001*** CI=0.63, 0.72
27) My cat is fearful	N=537 ICC3= 0.67	F=5.1 Df=536,536	P=<0.0001*** CI=0.62, 0.71
28) This cat has met all my expectations	N=536 ICC3=0.58	F=3.8 Df=535,535	P=<0.0001*** CI=0.52, 0.64
29) I am happy with my cat	N=543 ICC3=0.51	F=3.1 Df=542,542	P=<0.0001*** CI= 0.44, 0.57

30) I feel my cat is happy living with me	N=541 ICC3=0.47	F=2.8 Df=540,540	P=<0.0001*** CI=0.40, 0.53
31) I have considered rehoming this cat to someone else or returning this cat to the place of adoption	N=544 ICC3=0.58	F=3.8 Df=543,543	P=<0.0001*** CI=0.53, 0.64

6.2.3.3 Data reduction of QA.3 (adopter) items:

The final refined FA model consisted of six factors and contained a total of 23 items, all loading on at least one factor (either positively or negatively) at 0.40 or higher (See Table 6.5 below). Visual inspection of individual item means and standard deviations indicated little variability both between items and across factors. Correlations on the item correlation matrix were generally relatively low (the majority of items correlated between 0.01 and 0.5, with the highest correlations reaching 0.6 but only for two items) (see Table in appendix 6.4). Items that therefore loaded similarly highly on the same factor were not considered to be ‘replicates’ of each other (and thus redundant), and no items were removed from the final FA data set on this basis. Each factor was then interpreted based on the items loading at 0.40 or greater, in relation to the core emotional processes and contexts they were hypothesised to measure aspects of (see Table 6.5).

Table 6.5 Individual QA.3 (Cat adopter) items and their loadings on each of the six factors extracted during polychoric Factor Analysis performed on 31 items rated by adopters of a population of 244 cats across the four rehoming centres. Factor interpretations in relation to hypothesised core emotional processes, their contexts (either social or physical) and relevant traits are also indicated.

QA.3 Question item		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
q1	My cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)	-0.27	**-0.72**	0.15	0.27	-0.14	0.04
q2	My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks	-0.13	**-0.82**	0.15	0.19	-0.13	0.12
q3	My cat is comfortable being picked up	0.07	0.26	-0.14	-0.23	**0.59**	0.05
q4	When I initiate contact or interaction with my cat, it doesn't move away but it is quiet and not very responsive towards me (i.e. it doesn't purr or rub up against me)	0.19	**-0.62**	-0.19	-0.21	0.13	-0.13
q5	My cat is timid	-0.06	-0.26	0.02	**0.75**	-0.21	0.11
q8	My cat comes and asks me for attention and initiates contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)	0.10	**0.46**	-0.08	-0.30	0.20	-0.12
q9	My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it	-0.23	-0.14	**0.72**	0.09	-0.12	-0.01
q11	My cat is keen to explore new things in its environment	-0.31	-0.10	0.12	**-0.60**	0.07	0.09
q12	My cat is quick to settle and adapt to change	0.15	-0.23	-0.05	**-0.74**	0.18	-0.15
q14	My cat gets carried away during play, which has led to me being bitten or swiped at	0.00	-0.08	**0.59**	0.08	0.06	-0.03

q16	My cat likes being stroked	0.34	**0.46**	-0.22	-0.08	0.35	-0.12
q17	I avoid stroking or handling my cat because I feel that it doesn't want me to	-0.25	**-0.56**	**0.45**	0.08	-0.24	-0.02
q18	My cat is very tolerant to being handled	0.22	0.29	-0.16	-0.27	**0.83**	-0.14
q19	I avoid stroking my cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)	-0.30	-0.30	**0.84**	0.12	-0.07	0.03
q20	My cat seems angry around me	**-0.47**	-0.20	**0.62**	0.17	-0.13	-0.10
q21	If my cat could choose, it would prefer to have a bowl of food rather than interact with me	-0.13	-0.10	0.06	0.10	0.10	**0.79**
q22	My cat is more keen to interact with and be near me when I have food/ treats	-0.08	-0.10	0.01	-0.07	-0.13	**0.61**
q26	My cat is friendly	**0.44**	**0.40**	-0.24	-0.33	0.30	-0.07
q27	My cat is fearful	-0.11	-0.17	0.00	**0.68**	-0.20	0.09
q28	This cat has met all my expectations	**0.65**	0.28	-0.25	-0.15	0.25	-0.15
q29	I am happy with my cat	**0.89**	0.19	-0.25	-0.15	0.09	-0.08
q30	I feel my cat is happy living with me	**0.73**	0.30	-0.11	-0.18	0.09	-0.13
q31	I have considered rehoming this cat to someone else or returning this cat to the place of adoption	**-0.58**	-0.06	**0.50**	0.34	0.01	0.11
Interpretation given to each factor		**Owner/adopter satisfaction**	**SEEKING (social) And boldness**	**RAGE, (social)**	**FEAR(social /physical)**	**Handling tolerance – SEEKING social, Boldness**	**SEEKING (physical)**

Table 6.6 Summary of the Questionnaire QA.3 (Cat adopter) items loading at 0.40 or greater on the six factors produced from the final FA that were used to generate individual factor scores. Factor interpretations in relation to hypothesised core emotional processes, their contexts (either social or physical) and relevant traits are also indicated.

'Satisfaction' factor	**'Behaviour' factors**				
Factor 1: Owner 'satisfaction'	**Factor 2:** SEEKING (social) And boldness (i.e. an absence of FEAR)	**Factor 3:** RAGE, (social)	**Factor 4:** FEAR(social/ physical)	**Factor 5:** Handling tolerance – SEEKING (social), Boldness	**Factor 6:** SEEKING (physical)
q20	q1	q9	q5	q3	q21
q26	q2	q14	q11	q18	q22
q28	q4	q17	q12		
q29	q8	q19	q27		
q30	q16	q20			
q31	q17	q31			
	q26				

6.2.3.4 Predictive relationship between reliable rehoming centre measures and adopter reported behaviour.

Results of the mixed models indicated a significant relationship between social RAGE behavioural scores (sRB) from the rehoming centre measures and Factor 4 (social/physical FEAR) scores from adopter QA.3 questionnaires (n=37, X^2= 6.2114, df=1, p<0.01), suggesting that higher levels of 'meows' in the rehoming centre were associated with higher social/physical FEAR factor scores in the home environment (n=37, Estimate= 0.13257, standard error= 0.04793, Z= 2.77, p<0.001). No further significant relationship was indicated between any of the Behaviour test cluster scores (individually or as interactions) and QA.3 factor scores (n=37, all p>0.05). Additionally, no significant relationship was indicated between any of the (refined) L-CAT cluster scores (individually or as interactions) and any of the QA.3 factor scores (all p>0.05).

6.2.3.5 Predictive relationship between refined rehoming centre measures and adopter reported behaviour in relation to owner satisfaction:

No significant relationship was indicated between any of the Behaviour or (refined) L-CAT cluster scores (sSQ(r) and sFQ(r)) and 'satisfaction' factor scores, either individually or as interactions (n=37, all p>0.05). Additionally, no significant relationship was indicated between any of the six individual (refined) L-CAT item scores and 'satisfaction' factor scores, either individually or as interactions (n=37, all p>0.05).

6.2.4 Discussion:

6.2.4.1 L-CAT Clusters based on refined reliable items:

Whilst the removal of the four unreliable items from the original L-CAT resulted in the absence of a social RAGE cluster (i.e. sRQ), Figure 4.1, Chapter 4), the structure of the remaining measures remained stable, suggesting their consistency in the representation of the hypothesised core emotional processes (i.e. social SEEKING and social FEAR) from rehoming centre to home.

6.2.4.2 Longitudinal reliability of QA.3 (Cat owner population) items:

Analysis of the QA.3 (Cat owner) items assessed within the stable Cat Owner population indicated a significant level of stability in the ratings of all items, suggesting that the perceptions and observations of owners towards their cats are longitudinally stable (over a six month period).

6.2.4.3 Data reduction of QA.3 (Cat adopter population) items:

From the original 31 items, 23 had sufficiently high owner-response rates and also loaded highly on the final six factors that were extracted. Within each factor, individual items that were hypothesised to relate to aspects of the same underpinning core emotional processes also loaded similarly, suggesting a good level of convergent validity within the questionnaire. Items located within the same factor were also consistently more highly correlated with each other than they were with items located within other factors (see appendix 6.4), suggesting a good level of discriminant validity between each of the different proposed core process (e.g. see Campell and Fiske 1959).

As well as the primary processes of interest (FEAR, SEEKING and RAGE), several other factors were produced which were interpreted as relating to 'Handling tolerance' and 'Owner satisfaction'. Item 31 (owner considering relinquishing the cat) loaded negatively on Factor 1 (owner satisfaction) and positively on Factor 3 (social RAGE) and would suggest that higher social RAGE reactivity may potentially be an important factor in the consideration of cat relinquishment, as well as reduced owner satisfaction, a similar pattern was also indicated for item 20 ('when I am around this cat it seems angry'). This item loaded negatively on Factor 1 (owner satisfaction) and positively on Factor 3 (social RAGE) and would again suggest that people are indeed more satisfied with cats that are perceived to have lower levels of RAGE reactivity. Furthermore, item 26 (the friendliness of the cat) also loaded highly on Factor 1 (owner satisfaction), which would suggest that higher levels of perceived friendliness are also associated with higher owner satisfaction. These findings would support the initial hypotheses of this research that both human-sociability and propensity towards human-directed aggression are potentially key factors in relation to owner satisfaction and the potential 'homeability' or 'suitability' of cats. Such findings are also supported by previous research (Salman *et al* 2000, Amat *et al* 2009), and in a recent study, both aggressive behaviour and affection towards humans were found to negatively and positively correlate with owner satisfaction respectively (Onodera *et al* 2014).

6.2.4.4 Predictive relationship between reliable rehoming centre measures and adopter reported behaviours:

Neither of the (refined) L-CAT clusters (sSQ or sFQ) were found to be predictive of any of the post-adoption QA.3 questionnaire factors. However, due to the unreliability of the majority of the questionnaire items (either within the centre or between the centre and the home), a total of only six items were represented across both contexts (i.e. centre and home). It is thus possible that the refined L-CAT measures are insubstantial in their ability to fully represent the constructs (i.e. individual factors) that were identified from adopter reports of behaviour (e.g. QA.3 (adopter) data), particularly in relation to social RAGE which was not represented in the (refined) L-CAT.

Only one of the behavioural measure clusters (social RAGE) was significantly positively correlated with any of the QA.3 factors, but this was for the factor that was hypothesised to be associated with FEAR rather than RAGE as would have been anticipated. These results would support the conclusions of earlier chapters; that such types of gross behavioural measures are not necessarily affect specific, but potentially represent different aspects of emotional motivation that may vary with the individual and context, and thus cannot be used to reliably predict behavioural tendency.

6.2.4.5 Owner satisfaction:

Factor loadings suggested that both perceived friendliness (i.e. q26 ‘my cat is friendly’) and frustration (i.e. q20 ‘My cat seems angry around me’) were potentially important in relation to how satisfied owners felt with their cats (e.g. both these items loaded strongly on the same factor as the other items relating to ‘satisfaction’ (Factor 1)). However, none of the behavioural or (refined) L-CAT cluster measures were predictive of owner satisfaction (Factor 1 composite scores), and neither were any of the six L-CAT items when assessed individually or as interactions.

Such results suggest that the reliable L-CAT items do not fully represent all aspects of behaviour relevant to owner satisfaction, (for example whilst the item ‘when I am around this cat it seems angry’ was associated with QA.3 adopter satisfaction scores, it was not reliable from rehoming centre to home and thus could not be included in the (refined) L-CAT), and/or that there are other factors independent of the actual behaviour of the cat that may also influence perceived satisfaction. Indeed several studies would suggest that the characteristics or attributes of owners may be important determinants of perceived satisfaction (e.g. see Serpell 1996, Curb *et al* 2013), and potentially even more influential in relation to the nature of the pet-owner relationship than the actual behavioural traits displayed by the pet (Adamelli *et al* 2005, Meyer and Forkman 2014). Further exploration of such factors is important, given the evidence that suggests that the perceived presence of behaviours that are 'less desired' by owners may increase the risk of pet relinquishment (Wells and Hepper 2000, Kwan *et al* 2013), or could otherwise affect the pet-owner relationship in a way that is subsequently detrimental to the animals' welfare (e.g. see Adamelli *et al* 2005).

6.2.5 Conclusion:

Whilst six of the individual L-CAT items were found to be significantly stable between staff ratings in the rehoming environment and owner ratings within the home, no clear relationship between any of the composite rehoming measures (i.e. (refined) L-CAT clusters (sSQ, sFQ) or Behavioural test clusters (sRB, s/pSB)), and the composite adopter-reported behaviours (i.e. QA.3 (Cat adopter) factor scores) was found. Thus, the six (refined) L-CAT items may provide a reliable means of predicting future behavioural responses of cats post rehoming but potentially only in relation to *specific* aspects of social SEEKING and FEAR (and not of these emotional processes in a more general way), and not to social RAGE or owner satisfaction. The fact that relinquishment was so low within the test population may suggest that behavioural features of the cat may either not affect risk of relinquishment, or that those that did relinquish their cats were less inclined to provide follow-up information on them. However, because there is evidence to suggest that owner satisfaction has the potential to affect both the experiences of the cat and the cat owner, (and is potentially something that is easier to collect data on than relinquishment information) this is an important aspect to explore, and will be done so in future chapters.

6.2.5.1 Main findings and questions raised:

- The results of this chapter indicate limitations in the predictive validity of the models (i.e. the composite Behaviour and L-CAT measures) in relation to post-adoption behaviour profiles and levels of satisfaction as rated by owners.

- However, the results did suggest that *individual items* from a subset of the L-CAT model were predictive of post adotion behaviour and could thus be used within the rehoming environment to predict specific aspects of behavioural tedancy in the home, as well as manage owner expectations.

7 Chapter 7 - Owner ideals and satisfaction:

7.1 Introduction:

Because the reliable assessment measures developed within the rehoming environment were unable to predict owner satisfaction post adoption (see Chapter 6), in this chapter the potential influence of owner ideals and their perceptions are explored. This involved collecting information from people in relation to their expectations of a cat's behaviour pre-adoption, assessing this in relation to their experience of the cat's actual behaviour post-adoption, and also exploring how such factors may relate to how satisfied owners feel with their cat.

7.1.1 Chapter aims:

Data were collected from cat-owners prior to the selection of a cat using an adapted version of Questionnaire QA.1, (QA.2 (ideal)), in order to gauge their expectations in relation to the identified keys traits of interest (e.g. see Chapter 1). In combination with the QA.3 (Cat adopter) data previously collected, such information could then be used to;

i) Identify key behavioural items within QA.2 (ideal) that were potentially indicative of the most important or fundamental trait aspects to owners.

ii) Use QA.3 (adopter) data in order to determine whether these key (and other) QA.2 (ideal) behavioural items are associated with levels of owner 'satisfaction'.

iii) Use QA.3 'satisfaction' scores to determine whether less satisfied owners post-adoption can be identified based on their initial QA.2 (ideal) pre-adoption 'ideals'.

7.2 Methods:

7.2.1 Questionnaire development:

7.2.1.1 Item content:

Questionnaire QA.2 (ideal) (see appendix 7.1) was adapted from the original QA.1 questionnaire (see appendix 4.1) that had been designed to facilitate the assessing of cats in relation to the previously identified key traits of interest based around the core emotional processes relating to FEAR, SEEKING and RAGE (see Chapter 4). The original questionnaire content and format was maintained but with items being re-worded slightly so that they were relevant to potential adopters. An additional question was added to the beginning of QA.2: 'I'd like a cat I am able to work with (e.g. one that may be fearful or has other behavioural issues but that I can help to 'bring round')' because this was hypothesised to be an important aspect of owner variation that could potentially affect subsequent owner-reported satisfaction. Each item reflected a statement about the cat that was rated by potential adopters in relation to how important/unimportant or how strongly they agreed/disagreed with it. As with the other questionnaire versions, items were rated on a five-point Likert scale.

For ease of reference, items are referred to in abbreviated form throughout this chapter. Please refer to Appendix 7.2 for the full version of each questionnaire item.

7.2.1.2 Respondent demographics:

The questionnaire was designed to be filled out by individuals intending to adopt a cat at any of the four test centres partaking in the study (BDCH, CP, MHW, WG), prior to actual viewing and selection, so that their answers would be more likely to reflect true ideals rather than the characteristics of a particular cat they had already seen or chosen.

7.2.1.3 Data collection:

Questionnaires were presented to people with the usual paper work they were required to fill in as part of the rehoming process. The questionnaire contained a brief outline of the project as well as a statement ensuring that the information provided by respondents was confidential and would not be shared with the rehoming centres, nor would it affect their rehoming experience.

Respondents were required to consent to their involvement in the study by providing their name, signature and also contact details and so that they could be contacted for future post-rehoming follow up information. An envelope was provided with each questionnaire so that it could be sealed and then sent back to the University shortly after completion.

Each week, the names provided on the QA.2 (ideal) questionnaires were checked against the people that adopted cats, so that all relevant individuals that had filled in a QA.2 and then adopted a cat could then be sent a QA.3 (adopter) questionnaire following adoption. Questionnaires were sent 1 week after adoption either by post or via email, depending upon the recipient’s indicated preference. The average response time from adoption to completion of a QA.3 was approximately two weeks.

7.2.1.4 Data analysis and statistical methods:

Only one person that returned a QA.3 questionnaire had relinquished their cat at the time of questionnaire completion. Their responses were subsequently removed from the data set so that the sampled population contained only cat adopters that still currently had their cat. For each item, only responses from individuals with complete ratings for the items being compared were used (i.e. there were no missing values, ‘Unsures’ or ‘n/a’s), thus the sample size for each item analysed varied slightly (from 308-323). For both QA.2 (ideal) and QA.3 (adopter), only items with a response rate of 90% or greater were used in the subsequent analysis. To aid in the interpretation of statistical outputs, several item scales were reversed so that high scores represented high sociability, low fear, low frustration reactivity and also high owner satisfaction.

All statistical analyses were carried out in R software (version 3.1.0) (R Development Core Team, 2014).

7.2.1.4.1 Identifying key items (comparisons of ‘ideal’ (QA.2) and ‘actual’ (QA.3) ratings):

In order to identify the trait items that were potentially more fundamental or of greater importance to owners, an approach similar to Serpell (1983), and Mills & McNicholas (2005) was used. Wilcoxon matched-pairs signed ranks tests were performed on each individual item to assess the magnitude of difference between the ‘ideal’ (QA.2) and ‘actual’ (QA.3) ratings provided by adopters. Items that had the least amount of variability (and were thus the most consistent) between ideal and actual ratings were considered to ‘reflect the most important aspects of the relationship’ (Mills & McNicholas 2005). These items were identified via their Z scores and p values generated from the Wilcoxon tests.

7.2.1.4.2 Identifying QA.3 (owner) items predictive of ‘owner satisfaction’:

Based on the collective ratings of items q28-31 of questionnaire QA.3 (see Table 4.5, Chapter 4), ‘satisfaction’ scores were generated for each cat owner. These scores were then used in order to partition the data based on relative ‘satisfaction’.

Similarly to recent findings in both domestic dogs (see Curb *et al* 2013) and cats (Neidhart & Boyd 2002, Onodera *et al* 2014), the majority of owners were generally very satisfied with their adopted pet (see histogram in Figure 7.1 for score distributions), thus in order to facilitate meaningful comparisons, data were partitioned based on owners who either scored the highest possible satisfaction rating (20) or scored 19 or less.

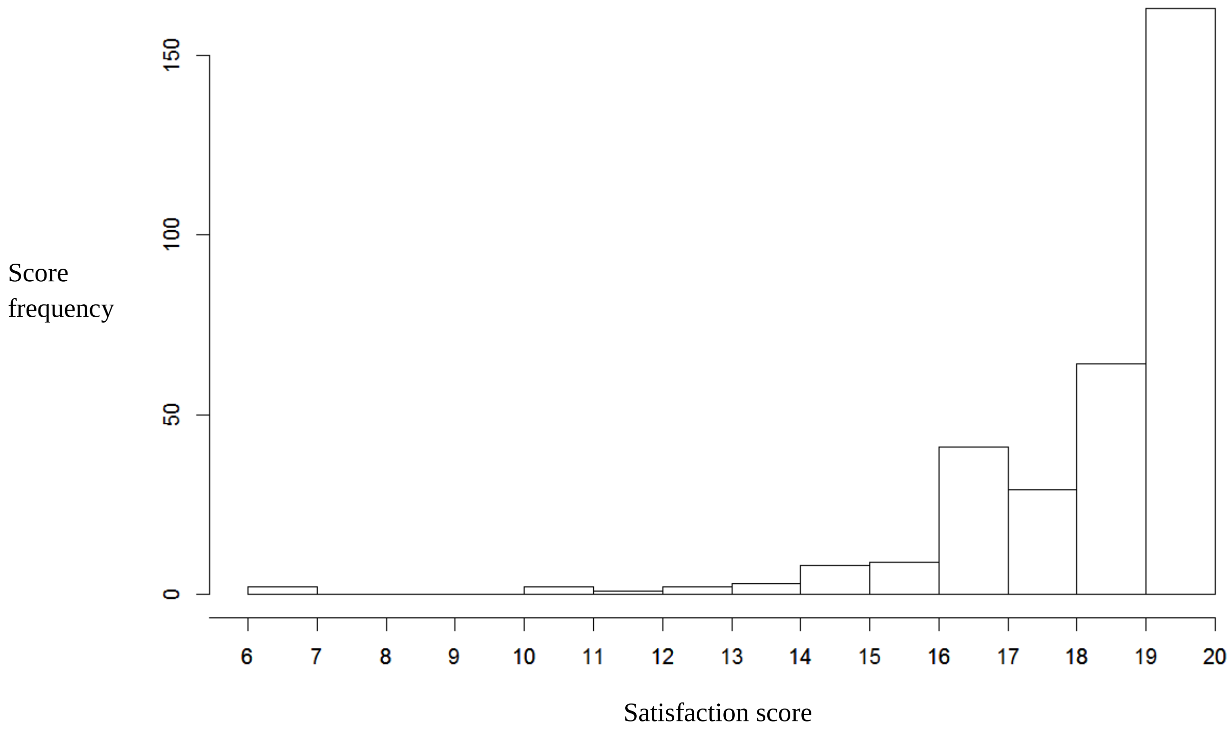

Figure 7.1 Histogram of adopter 'satisfaction' scores (q.28-31 of QA.3 combined total), (*n=324)*. Scores ranged from 6-20. The minimum possible score was four and maximum 20. Higher scores reflect higher levels of 'satisfaction'.

This led to an approximately equal distribution of individuals between the two groups. In order to then determine which items were associated with higher satisfaction, Mann-Whitney-Wilcoxon Tests were used so that the variability in ratings between owners that were either 'Completely satisfied' (scoring 20) or 'Not completely satisfied' (scoring ≤19) for each QA.3 item could be compared.

7.2.1.4.3 Predicting less 'satisfied' owners based on QA.2 (ideal) item ratings:

Using the same method to partition the cat-owner population based on satisfaction scores, the 'ideal' Questionnaire QA.2 item ratings from 'Completely satisfied' and 'Not completely satisfied' owners were compared in order to determine whether less satisfied owners could be identified based on their initial 'ideal' ratings of items. All QA.2 ratings had response rates >90% thus all 28 items were included. Data from the two populations (‘Completely satisfied’ and ‘Not completely satisfied’) were compared using Mann-Whitney-Wilcoxon Tests.

7.3 Results:

7.3.1 Identifying key items (comparisons of ‘ideal’ (QA.2) and ‘actual’ (QA.3 (adopter)) ratings): (see Figure 7.2 and Table 7.1)

Two QA.3 (owner) items had response rates <90%; ‘cat behaves aggressively during medical procedures etc.’ and ‘cat behaves differently with strangers than the owner’. These items were thus removed prior to analysis.

Of the remaining 25 items that were analysed, many of the ‘actual’ (QA.3) item ratings significantly exceeded those of the ideal (all $P<0.0001$ with substantially larger Z scores (indicating greater variation)). These included items associated with aggressive behaviour towards humans, friendliness, exploratory behaviour, playfulness, with actual cats being rated more ‘positively’ (i.e. more friendly, less aggressive, more bold and more playful etc.) than their ‘ideal’ counterparts.

In contrast, for several other items, the cats’ actual ratings were less ‘positive’ than the owners ideals, with cats being significantly more avoidant of interaction, behaving differently with different household members, less comfortable being picked up, less enjoying of long stroking sessions, less vocal, less keen to interact with people without food present (all $P<0.0001$), less handling tolerant and finally less of a preference for human interaction over food (both $p<0.05$), all having significantly large negative Z scores.

Altogether, a total of five items did not differ significantly between ‘actual’ and ‘ideal’ ratings (all $p>0.05$), also having substantially smaller Z scores. These items included ‘Prefers to be with people than be alone’, ‘Likes being stroked’, ‘Initiates interaction’, ‘Non-avoidant during contact’ and ‘Not fearful’).

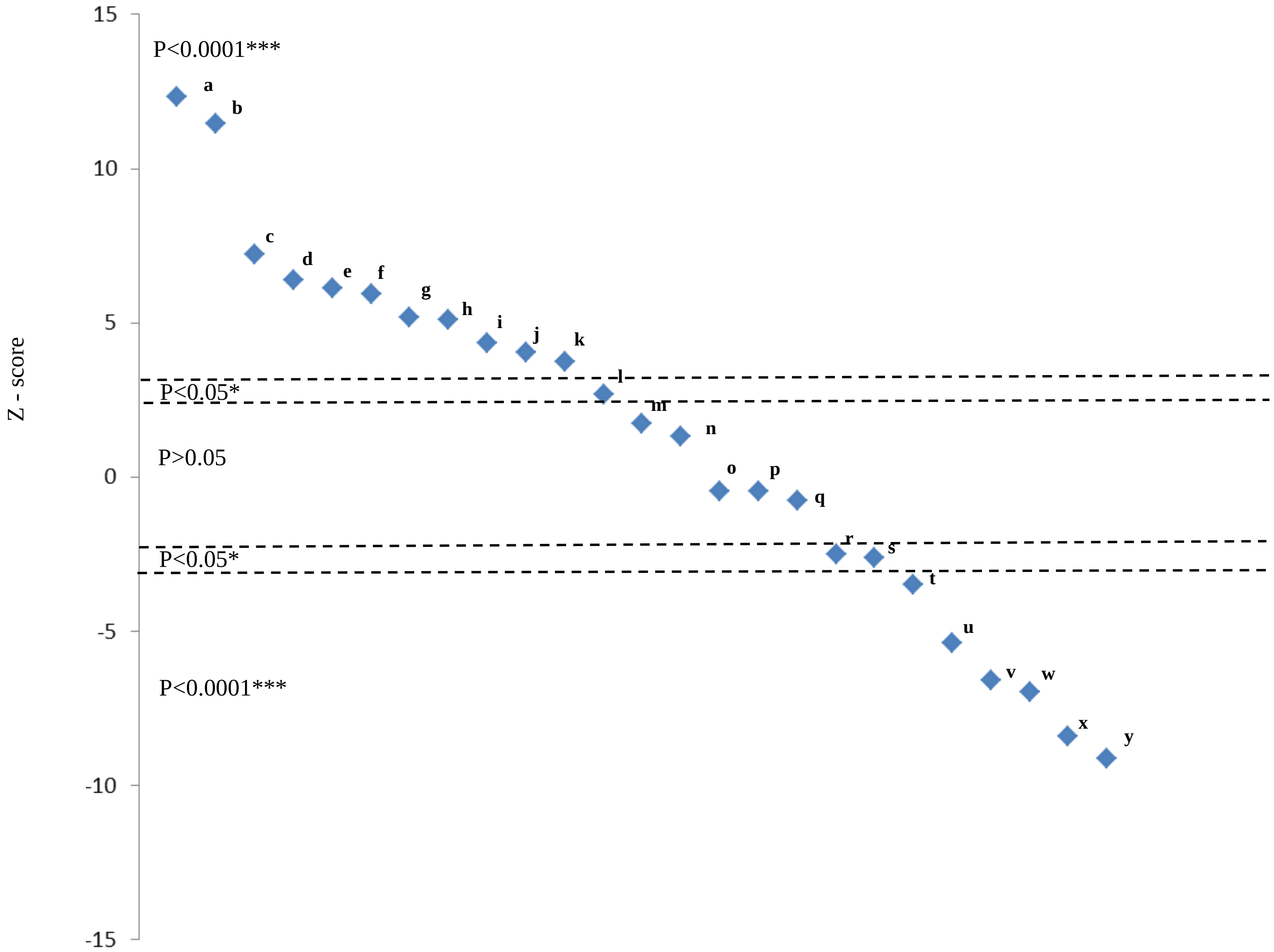

Figure 7.2 Scatter plot of Z scores for each item comparing QA.2 'ideal' with QA.3 'actual' owner ratings, created using Wilcoxon matched-pairs signed ranks test. Z scores plotted by values, from positive to negative. Dotted lines indicate groups of items with different levels of relative statistical significance. Items represented in abbreviated form. See Appendix 7.2 for full item content. Super script key for each data point is a follows: [a]Doesn't seem angry, [b]Never avoid stroking due to worry of aggression, [c]Friendly, [d]Doesn't aggress during play, [e]Doesn't aggress when stroked, [f]Explorative, [g]Positively responsive to interaction, [h]Playful, [i]Not timid, [j]Quick to settle/adapt to change, [k]Happy living with owner, [l]Cat suitable so won't want to rehome, [m]Prefer to be with people than be alone, [n]Likes being stroked, [o]Initiates interaction, [p]Non-avoidant during contact, [q]Not fearful, [r]Handling tolerant, [s]Prefers human interaction to food, [t]Non-avoidant when interaction encouraged, [u]Behaves same with all household members, [v]Vocal towards people, [w]Comfortable being picked up, [x]Enjoys long stroking sessions, [y]Keen to interact even without food.

Table 7.1 Statistical output from the Wilcoxon‘s matched pairs signed ranks test comparing the ‘ideal’ and ‘actual’ ratings adopters provided pre (QA.2) and post (QA.3) adoption. Population size (n), v and p values as well as confidence intervals and Z scores are provided along with the medians and Inter Quartile ranges for each individual item. Items in bold reflect the tests where differences were not statistically significant.

								‘ideal' (QA.2) ratings		**‘actual' (QA.3) ratings**	
Question		**n**	**v**	**p**	**CI lower**	**CI upper**	**z**	**median**	**IQR**	**median**	**IQR**
1	Non-avoidant when interaction encouraged	323	16663	<0.0001***	0.000056388455.000420e-01	5.00E-01	-3.50279	4	1	4	2
2	**Non-avoidant during contact**	**322**	**14337**	**0.634**	-3.97E-05	5.29E-06	**-0.47606**	**4**	**1**	**3**	**0**
3	Comfortable being picked up	303	15891.5	<0.0001***	0.50002	1.000038	-6.97306	4	0	4	1
4	Positively responsive to interaction	319	9547	<0.0001***	-1.00E+00	-4.74E-05	5.167161	4	1	5	2
5	Not timid	318	9304	<0.0001***	-1.00E+00	-4.90E-05	4.331834	3	1	4	2
6	Enjoys being stroked	322	23770	<0.0001***	0.99996	1.000047	-8.4065	4	1	3	1
7	Vocal towards people	308	16139.5	<0.0001***	0.500083	1.00E+00	-6.6046	4	1	3	1
8	**Initiates interaction**	**321**	**10399.5**	**0.6516**	-1.60E-05	4.96E-05	**-0.45149**	**4**	**0**	**4**	**2**
9	Doesn’t aggress when stroked	322	5379.5	<0.0001***	-1.00E+00	9.34E-10	6.121483	4	1	4	0
11	Explorative	318	8419.5	<0.0001***	-0.99998	-0.99995	5.946351	4	1	5	1
12	Quick to settle/adapt to change	316	6832.5	<0.0001*	-1.00E+00	-1.20E-	4.028934	4	1	4	1

				**		05					
13	Playful	319	6118	<0.0001***	-1.00E+00	-3.67E-06	5.0851	4	0.5	4	1
14	Doesn’t aggress during play	317	8583	<0.0001***	-1.49999	-0.50006	6.40568	3	1	5	2
15	**Prefer to be with people than be alone**	**320**	**8087.5**	**0.08457**	-5.00E-01	2.14E-05	**1.726096**	**4**	**1**	**4**	**2**
16	**Likes being stroked**	**321**	**8941.5**	**0.1903**	-5.00E-01	9.46E-06	**1.310907**	**4**	**1**	**4**	**1**
17	Handling tolerant	314	12215.5	<0.05*	4.65E-06	5.00E-01	-2.48253	4	0	4	2
18	No worry cat will aggress when stroked	320	3143.5	<0.0001***	-1.49993	-1.00002	-11.451	4	1	5	0
19	Not angry	316	2369.5	<0.0001***	-1.00006	-1.00008	-12.312	4	0	5	0
20	Prefers human interaction to food	308	11739	<0.01*	1.52E-05	5.00E-01	-2.60379	3	1	3	2
21	Keen to interact even without food	300	28181	<0.0001***	0.999964	1.499995	-9.13794	4	0	2	0.25
26	Friendly	321	7044	<0.0001***	-1.00003	-0.99998	7.20278	3	-1	4	0
27	**Not fearful**	**312**	**12389**	**0.4503**	-4.89E-05	8.17E-07	**-0.75488**	**4**	**0**	**4**	**1**
29	Happy living with owner	319	4648.5	<0.0001***	-1.00E+00	-1.40E-05	3.744848	4	1	4	0
31	Choose right cat so won’t have to rehome	321	1284	<0.01*	-0.99995	-4E-05	2.676204	5	0	5	0

7.3.2 Identifying QA.3 ‘actual’ items associated with ‘owner satisfaction’: (see Figure 7.3 and Table 7.2).

Of the twenty-five items analysed, the majority were rated significantly higher (i.e. more positively) by people that were completely satisfied (i.e. scoring 20), compared to those that were not completely satisfied (i.e. scoring $\leq$ 19) with their recently adopted cat.

The items where no significant difference (all $p>0.05$) in ratings between ‘completely satisfied’ and not ‘completely satisfied’ owners included ‘cat being keen to interact with people without food present’, ‘cat behaves aggressively during play’, ‘cat being vocal’, ‘cats’ behaviour consistent since adoption’ and ‘cat behaves the same with all people in the household’. Interestingly, these items were also previously identified as being some of the most variable or inconsistent between owner ‘ideal’ (QA.2) and ‘actual’ (QA.3) ratings (all $p<0.001$). In some cases ‘ideal’ items were rated as higher than ‘actual’ items and in others the opposite was true (see Figure 7.3 and Table 7.2).

In contrast, the items that were previously identified as being the least variable/ most consistent between ‘ideal’ and ‘actual’ ratings (e.g. ‘Prefer to be with people than be alone’, ‘Likes being stroked’, ‘Initiates interaction’, ‘Non-avoidant during contact’ and ‘Not fearful’)(see Figure 7.2 and Table 7.1), were amongst some of the items with the highest Z scores, being scored significantly more highly by satisfied owners (all $p<0.0001$) (see Figure 7.3 and Table 7.2). Such results would suggest that items that are more consistent between ideal and actual ratings also feature strongly in relation to the relative perceived satisfaction of owners.

Completely satisfied ratings > Not completely satisfied ratings

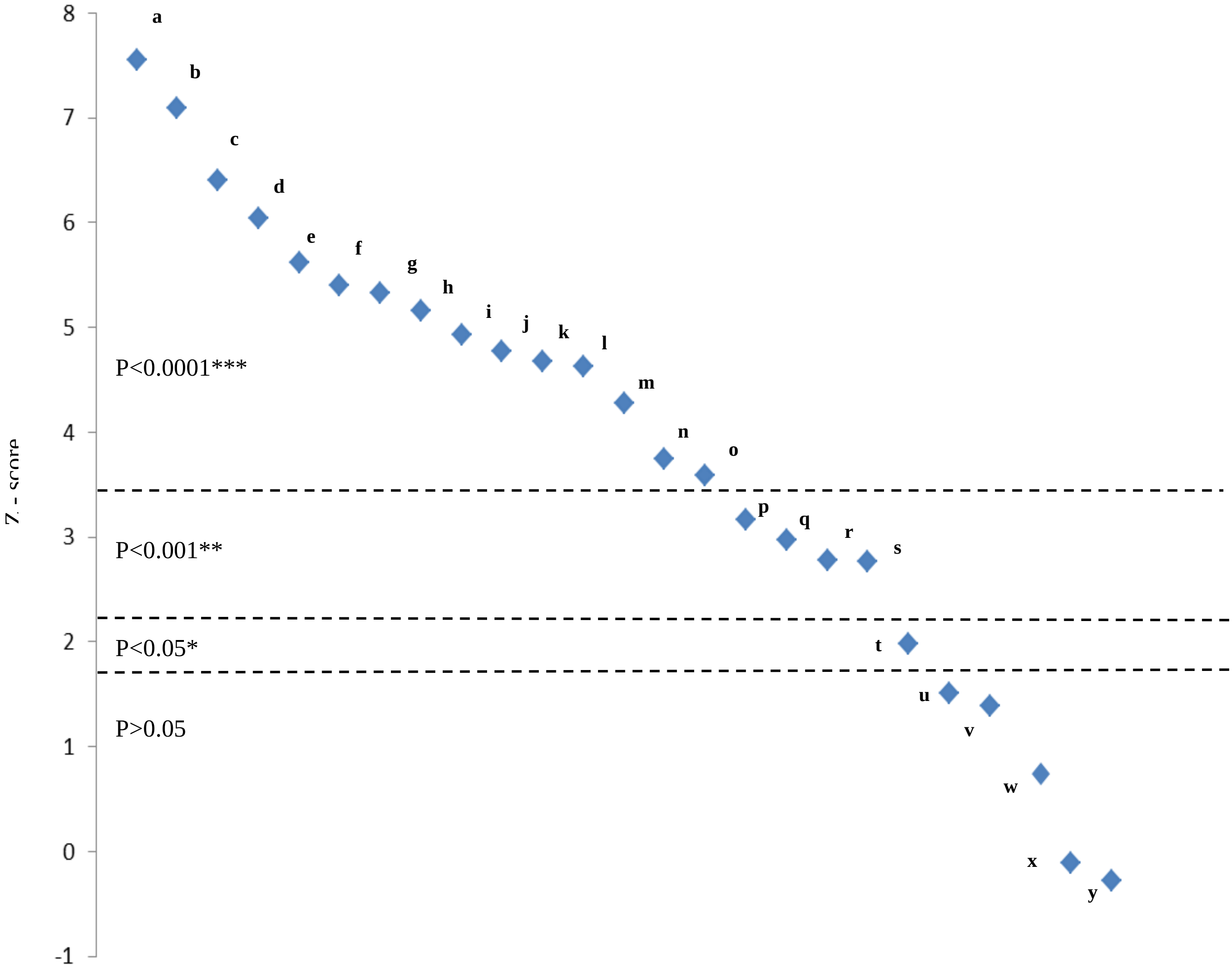

Figure 7.3 Scatter plot of Z scores for each item comparing QA.3 'actual' ratings between 'completely satisfied' and 'not completely satisfied' adopter ratings, created using Mann-Whitney-Wilcoxon Tests. Z scores plotted by value. Dotted lines indicate groups of items with different levels of relative statistical significance. Items represented in abbreviated form. See Appendix 7.2 for full item content. Super script key for each data point is a follows: [a]Handling tolerant, [b]Friendly, [c]Non-avoidant when interaction encouraged, [d]Quick to settle/adapt to change, [e]Positively responsive to interaction, [f]Likes being stroked, [g]Non-avoidant during contact, [h]Initiates interaction, [i]Prefer to be with people than be alone, [j]Never avoid stroking due to worry of aggression, [k]Comfortable being picked up, [l]Playful, [m]Not timid, [n]Doesn't aggress when stroked, [o]Not fearful, [p]Prefers human interaction to food, [q]Doesn't seem angry, [r]No worry cat will aggress when stroked, [s]Explorative, [t]Keen to interact even without food, [u]Vocal towards people, [v]Doesn't aggress during play, [w]Behaves same with all household member, [x]Behaviour consistent since adopted, [y]Will stay for long stroking sessions.

Table 7.2 QA.3 Statistical output from the Mann-Whitney-Wilcoxon test comparing QA.3 items ratings between adopters that were scored as being completely satisfied (scoring 20) and those that were scored as being less than completely satisfied (<20). Population size (n), v and p values as well as confidence intervals and z scores are provided along with the medians and Inter Quartile ranges for each individual item. Items in bold reflect the tests where differences were statistically significant.

Question								Not completely satisfied		Completely satisfied	
		n	v	p	CI lower	CI upper	z	median	IQR	median	IQR
1	**Non-avoidant when interaction encouraged**	**318**	**7834.5**	**<0.0001*** **	**-1.00005**	**-1.30E-05**	**6.408529**	**3**	**2**	**5**	**2**
2	**Non-avoidant during contact**	**318**	**8589**	**<0.0001*** **	**-0.99995**	**-5.80E-05**	**5.325484**	**3**	**2**	**5**	**1**
3	**Comfortable being picked up**	**298**	**7729**	**<0.0001*** **	**-0.99999**	**-5.10E-05**	**4.676058**	**3**	**2**	**4**	**2**
4	**Positively responsive to interaction**	**315**	**8273**	**<0.0001*** **	**-0.99998**	**-5.50E-05**	**5.624097**	**3**	**2**	**5**	**1**
5	**Not timid**	**313**	**8946.5**	**<0.0001*** **	**-0.99996**	**-3.10E-05**	**4.281611**	**3**	**2**	**4**	**1**
6	Will stay for long stroking sessions	316	12686	0.7821	-4.80E-05	6.37E-05	-0.27654	3	1	3	1
7	Vocal towards people	305	10526	0.1307	-4.70E-05	4.90E-05	1.512686	3	1	3	1
8	**Initiates interaction**	**316**	**8566**	**<0.0001*** **	**-0.99998**	**-7.30E-05**	**5.160531**	**4**	**1**	**4**	**1**
9	**Doesn't aggress when stroked**	**317**	**10832**	**<0.01***	**-5.90E-05**	**-3.90E-05**	**2.780903**	**5**	**1**	**5**	**0**
11	**Explorative**	**316**	**10474.5**	**<0.01***	**-5.80E-06**	**-9.90E-06**	**2.764468**	**4**	**1**	**5**	**1**
12	**Quick to settle/adapt to change**	**313**	**7753.5**	**<0.0001*** **	**-0.99992**	**-1.30E-05**	**6.037673**	**4**	**1**	**4**	**1**
13	**Playful**	**315**	**8945**	**<0.0001*** **	**-0.99997**	**-1.40E-05**	**4.632977**	**4**	**1**	**5**	**1**
14	Doesn't aggress during play	313	11244.5	0.1671	-3.70E-05	5.05E-05	1.382937	5	2	5	2
15	**Prefer to be with people than be alone**	**315**	**8667**	**<0.0001*** **	**-0.99994**	**-8.70E-05**	**4.932161**	**4**	**1**	**4**	**1**
16	**Likes being stroked**	**318**	**8604.5**	**<0.0001*** **	**-0.99996**	**-2.20E-05**	**5.396524**	**4**	**1**	**5**	**1**
17	**Not worried cat will be aggressive when stroked**	**317**	**9973**	**<0.001** **	**-3.90E-06**	**-2.70E-05**	**3.73997**	**5**	**2**	**5**	**0**
18	**Handling tolerant**	**314**	**6554.5**	**<0.0001*** **	**-1.00004**	**-0.99998**	**7.547384**	**4**	**1**	**4**	**1**
19	**Never worried cat will aggress when stroked**	**318**	**10267**	**<0.0001*** **	**-6.00E-05**	**-8.70E-05**	**4.778199**	**5**	**0**	**5**	**0**
20	**Not angry**	**315**	**11211.5**	**<0.01***	**-6.40E-06**	**2.92E-05**	**2.974017**	**5**	**0**	**5**	**0**
21	**Prefers human interaction to food**	**308**	**9492**	**<0.01***	**-0.99994**	**-9.60E-05**	**3.167206**	**3**	**2**	**3**	**1**
22	**Keen to interact even without food**	**300**	**9827.5**	**<0.05***	**-1.70E-05**	**1.19E-07**	**1.976834**	**3**	**1**	**3**	**2**

23	Behaviour consistent since adopted	308	11941	0.9112	-2.30E-05	4.52E-05	-0.11156	2	1	2	2
26	**Friendly**	**318**	**7385**	**<0.0001***	**-0.99997**	**-4.80E-05**	**7.098448**	**4**	**1**	**5**	**1**
27	**Not fearful**	**312**	**9411.5**	**<0.001**	**-0.99996**	**-4.50E-06**	**3.586469**	**4**	**2**	**4**	**2**

7.3.3 Identifying less 'satisfied' owners based on individual QA.2 'ideal' ratings: (see Figure 7.4 and Table 7.3)

Of the 26 'ideal' item ratings compared, only three were found to vary significantly between 'completely satisfied' and 'not completely satisfied' owners - these were 'cat likes being stroked', 'cat is friendly' and 'cat is happy living with the owner'. These items were all rated as being significantly more important to owners that were then 'completely satisfied' with their cats post-adoption.

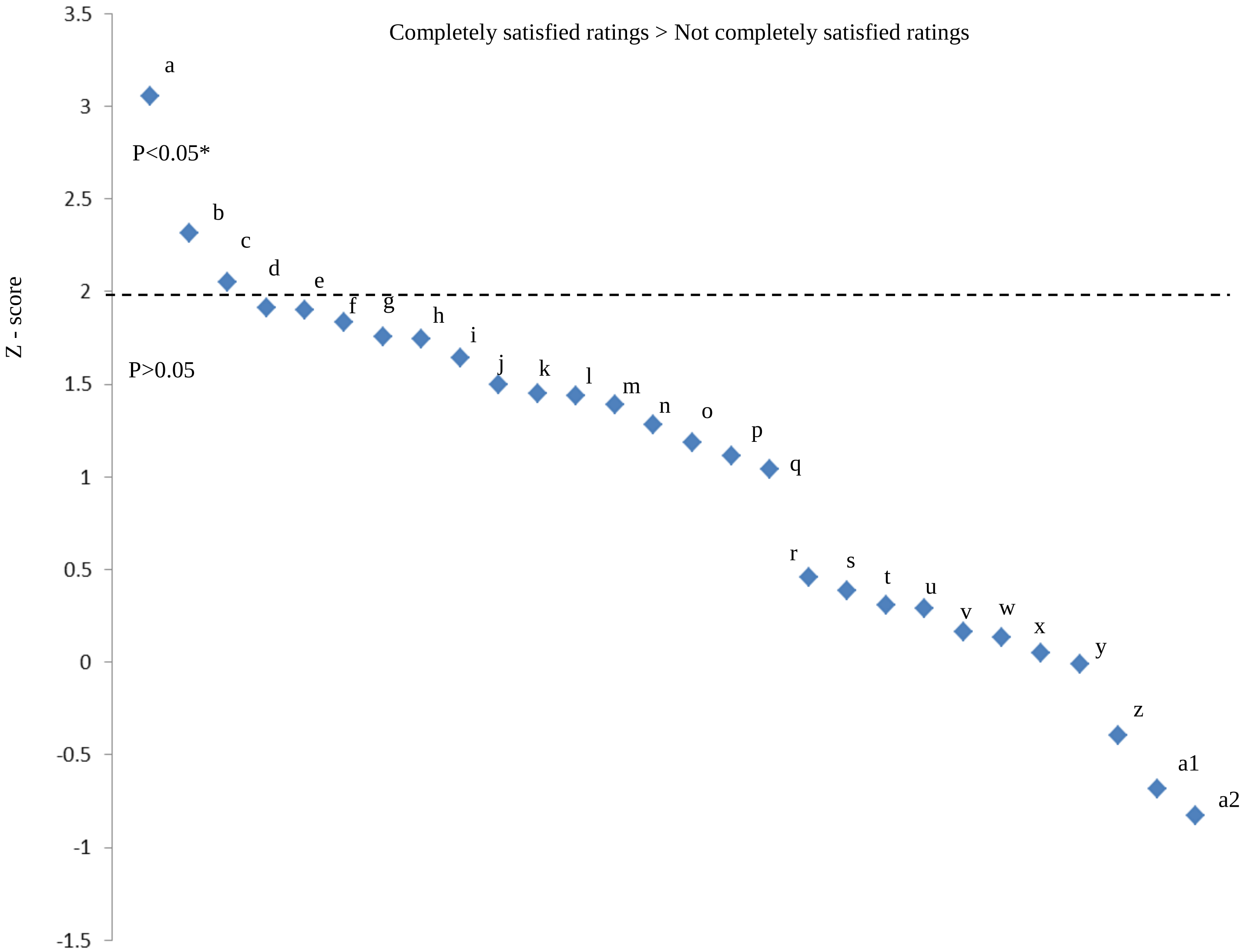

Figure 7.4 Scatter plot of Z scores for each item comparing QA.2 'ideal' ratings between 'completely satisfied' and 'not completely satisfied' owner ratings, created using Mann-Whitney-Wilcoxon Tests. Z scores plotted by value (from positive to negative). Dotted lines indicate groups of items with different levels of relative statistical significance. Items represented in abbreviated form. See Appendix 7.2 for full item content. Super script key for each data point is a follows: [a]Likes being stroked, [b]Happy living with owner, [c]Friendly, [d]Behaves same with all household members, [e]Initiates interaction, [f]Choose right cat so won't have to rehome, [g]Prefer to be with people than be alone, [h]Quick to settle/adapt to change, [i]Explorative, [j]Handling tolerant, [k]Vocal towards people, [l]Playful, [m]Positively responsive to interaction, [n]Prefers human interaction to food, [o]Non-avoidant when interaction encouraged, [p]Doesn't aggress during medical procedures etc., [q]Keen to interact even without food, [r]Non-avoidant during contact, [s]Will stay for long stroking sessions, [t]Doesn't aggress during play, [u]Not timid, [v]Never avoid stroking due to worry of aggression, [w]Comfortable being picked up, [x]Behaves same with owner and strangers, [y]Doesn't aggress when stroked, [z]Want a cat can bring round, [a1]Doesn't seem angry, [a2]Not fearful.

Table 7.3 Statistical outputs from the Mann-Whitney-Wilcoxon test comparing the QA.2 items ratings between owners that were scored as being completely satisfied (scoring 20) and those that were scored as being less than completely satisfied (<20) (based on QA.3 responses). Population size (n), v and p values as well as confidence intervals and z scores provided along with the medians and Inter Quartile ranges for each individual item. Items in bold reflect the tests where differences were statistically significant.

								Not completely satisfied		Completely satisfied	
	Question	n	v	p	CI lower	CI upper	z	median	IQR	median	IQR
1.A	Want a cat can bring round	318	11917.5	0.6917	-2.51902E-05	2.10792E-05	-0.3965	3	1	3	1
1	Non-avoidant when interaction encouraged	305	11759	0.2374	-4.51206E-05	2.25667E-05	1.18278	4	1	4	1
2	Non-avoidant during contact	318	12300.5	0.6496	-1.93726E-06	4.33046E-05	0.45573	4	1	4	1
3	Comfortable being picked up	316	12377	0.8927	-0.000048475	5.1117E-05	0.13622	4	2	4	2
4	Positively responsive to interaction	316	11442	0.1655	-1.72455E-05	5.5923E-05	1.38815	4	1	4	1
5	Not timid	317	12341.5	0.7744	-1.18604E-05	1.1536E-05	0.28798	3	1	3	1
6	Will stay for long stroking sessions	318	12270.5	0.6982	-1.72848E-05	5.51895E-05	0.38908	4	1	4	1
7	Vocal towards people	315	11341.5	0.1478	-1.77141E-05	3.48689E-05	1.44863	3	1	4	1
8	Initiates interaction	314	11036.5	0.05755	-4.74327E-05	6.41595E-05	1.90061	4	0	4	0
9	Doesn’t aggress when stroked	317	12565	0.9931	-4.1248E-05	4.2062E-05	-0.0086	4	1	4	1
10	Doesn’t aggress during medical procedures etc.	316	11630.5	0.2674	-2.13519E-05	5.94736E-05	1.11041	4	1	4	1
11	Explorative	315	11249	0.101	-4.44228E-05	2.1731E-05	1.64136	4	1	4	0
12	Quick to settle/adapt to change	316	11215.5	0.08147	-6.66255E-06	1.94925E-05	1.74359	3	1	4	1
13	Playful	317	11556	0.1505	-1.70329E-05	1.15776E-05	1.4392	4	1	4	0
14	Doesn’t aggress during play	317	12328.5	0.7587	-3.08701E-05	9.87354E-06	0.30852	3	1	3	1
15	Prefer to be with people than be alone	317	11312	0.0796	-2.6732E-05	2.58206E-05	1.7544	4	1	4	0.25
16	**Likes being stroked**	317	**10374**	**<0.001****	**-6.31233E-05**	**-5.75608E-06**	**3.05182**	**4**	**1**	**4**	**1**
17	Handling tolerant	313	11151	0.1345	-2.36193E-05	1.44734E-05	1.49786	4	1	4	1
18	Never worried cat will aggress when stroked	316	12356	0.87	-4.77781E-05	6.0301E-05	0.16496	4	1	4	1

19	Not angry	314	12810	0.4956	-3.78569E-06	2.1309E-05	-0.6815	4	0	4	1
20	Prefers human interaction to food	313	11337	0.2003	-8.30966E-06	3.42813E-05	1.28198	3	1	3	1
21	Keen to interact even without food	315	11714	0.2987	-3.05426E-05	5.92668E-05	1.04074	4	0	4	0
22	Behaves same with owner and strangers	313	12206.5	0.9609	-7.39112E-05	3.55649E-05	0.05043	3	1	3	1
23	Behaves same with all household members	301	10052.5	0.05611	-6.08322E-07	2.59813E-06	1.91169	4	1	4	0
24	**Friendly**	**316**	**10917**	**<0.05***	**-1.06935E-05**	**2.46385E-05**	**2.05068**	**4**	**1**	**4**	**1**
25	Not fearful	312	12770.5	0.4071	-1.54387E-05	5.39366E-05	-0.829	4	1	4	1
26	**Happy living with owner**	**317**	**10919**	**<0.05***	**-3.15595E-06**	**-5.03735E-05**	**2.31619**	**4**	**1**	**4**	**1**
27	Choose right cat so won’t have to rehome	316	11453.5	0.06703	-5.58379E-05	3.39734E-05	1.83329	5	0	5	0

7.4 Discussion:

Comparisons between ‘ideal’ and ‘actual’ ratings indicated a total of five items that were most consistent, suggesting these are potentially of more fundamental importance to cat-owners (e.g. Serpell 1983, Mills & McNicholas 2005). This conclusion is further supported by the fact that all of these items were amongst those rated most highly by more satisfied adopters. These items represented aspects hypothesised to relate to sociability (i.e. ‘Prefers to be with people than be alone’, ‘likes being stroked’, ‘initiates interaction’), fearfulness (i.e. ‘Not fearful’) and their potential combination (i.e. ‘Non-avoidant during contact’).

Various other items had ‘actual’ ratings that exceeded their ‘ideal’ counterparts and these were also rated significantly more positively by completely satisfied people (e.g. ‘less aggressive’, ‘more playful’, ‘settling more quickly in novel environments’, ‘more friendly’ and ‘doesn’t seem angry’ (these last two items also loaded strongly on the ‘Satisfaction’ factor in Chapter 6)). Such items may thus also be important determinants of owner satisfaction.

Interestingly, in contrast to some of the current findings, a previous study of cat owners (Serpell 1996) found that people rated their actual cats as being significantly *less* affectionate, *more* aggressive, *less* playful and *less* confident/relaxed in novel situations than their ‘ideal’ counterparts, whilst a more recent study (Onodera *et al* 2014) found that cats were rated as significantly more aggressive, but not more or less affectionate than their ideals. Such inconsistencies between studies could potentially be explained by the fact that in the present study, the people surveyed were *prospective owners* about to rehome a ‘rescue’ cat and could thus be likely to want to appear more ‘flexible’ or have more ‘realistic’ expectations about the type of cat they were willing to adopt, compared with people that were *already* the owner of the cat at the time they filled in an ‘ideal’ questionnaire (Serpell 1996, Onodera *et al* 2014), (and who may not have originally obtained their cat from a rehoming centre to begin with (Serpell 1996)).

In relation to the six L-CAT items that were stable from rehoming centre to home (see Chapter 6), two of the five ‘consistent’ items identified above (‘Initiates interaction’ and

‘Non-avoidant during contact’, see Figure 7.2) were also represented within the L-CAT, and in total, five of the six L-CAT items featured strongly in the list of items rated significantly higher by satisfied people (see Figure 7.3). As such, these five L-CAT items can not only be used to determine the likely future behavioural responses of cats, but potentially also contribute towards reliably gauging how satisfied prospective owners are likely to be with a particular cat, in relation to these specific behavioural tendencies.

At the time of QA.3 (adopter) questionnaire being completed (and also at the end of a six month follow-up period) only one adopter that filled in a Q.A3 had returned their cat, thus it was not possible to determine which items may be most important in relation to actual cat relinquishment. Whilst previous research has indicated aggression towards people may be amongst some of the more common behavioural reasons for relinquishment (Salman *et al* 2000), as previously mentioned, there is also evidence to suggest that owner-perceived desirability of a *range* of different behaviours could influence relative relinquishment risk (Wells and Hepper 2000, Kwan *et al* 2013). It is therefore possible that the above items that were identified as being important in relation to satisfaction *could* also feature prominently in relation to relinquishment for behavioural reasons, (although perhaps after a longer period of ownership than was documented in the current study), however further research would be required to test this hypothesis.

Comparing the initial ‘ideal’ ratings given by people that were then classified as being either ‘completely satisfied’ or ‘not completely satisfied’ with their cats post-adoption, the two populations were only distinguishable on three items. The cat being friendly, liking being stroked, and being happy living with the owner were all rated as being significantly more important by owners that were subsequently more satisfied with their cats. Whilst these results may appear counter-intuitive based on the assumption that higher or more specific expectations might lead to greater dissatisfaction (e.g. see Patronek *et al* 1996), these results could potentially suggest that owners that view these traits as being more important are perhaps making different or more ‘suitable’ choices in terms of the cat they then adopt. Again, further research in this area would be beneficial and may help elucidate the possible reasons for the higher ideal ratings given for these specific items by more satisfied people.

7.5 Conclusion:

This chapter has highlighted the potential importance of a range of individual trait-items (based on the theoretical framework used throughout this research – e.g. see Chapters 1 and 4) that are also associated with higher satisfaction post-adoption. Five of the (refined) L-CAT items that were consistent between the rehoming environment and the home (see Table 7.4 and also Chapter 6) also (individually) featured highly in relation to post-adoption satisfaction. As such, these measures provide the first tool of its kind that can generate practical, non-invasive and reliable behavioural information about cats within the rehoming environment, in relation to their current and future behaviour, that could potentially also help to gauge aspects of likely owner satisfaction post-adoption in relation to these behavioural tendencies. Further research exploring whether such information has the potential to improve both the initial matching of cats with owners (based on cat (refined) L-CAT scores and owner 'ideals') as well as owner post-adoption satisfaction may be an important next step in the improvement of not only the rehoming process, but also quality of the cat-owner relationship, in addition to the general welfare of the cat.

Because however, the (refined) L-CAT items did not feature heavily amongst those that were most consistent between 'ideal' and 'actual' ratings, and they were not actually able to predict composite owner satisfaction scores *per se* (see Chapter 6), it is possible that such items do not represent all facets of behaviour relevant to this construct. Because additionally, 'satisfied' and not 'completely satisfied' owners were not greatly differentiable based on their initial 'ideal' item ratings (at least in the ways that might have been expected), further work looking more closely at other individual attributes of owners (such as levels of owner attachment or 'personality types', e.g. see Serpell 1996, Stammbach & Turner 1999, Wedl *et al* 2011, Curb *et al* 2013) may add an extra important dimension to the understanding of factors relevant to adopter satisfaction, that may potentially interplay with the behavioural attributes of the cat (that can currently be reliably predicted and have demonstrated associations with satisfaction). Such research may thus further help in the optimal matching of individual cats with specific owners.

Table 7.4 Summary of items consistent between rehoming environment and the home, that were also associated with higher owner satisfaction, mapped against specific behavioural traits and their hypothesised relationship to underpinning emotional processes (marked with an 'X') and additionally whether they involve social elements (s) (i.e. in relation to the human in an interactive capacity), or physical elements (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

Repeatable questionnaire items	**Sociability (social) SEEKING**	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social/physical) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability**
This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks				**X(s)**		**X(s)**		
This cat is timid				**X(s,p)**				
This cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it				**X(s)**	**X(s)**	**X(s)**		
This cat likes being stroked	**X(s)**	**X(s)**	**X(s)**					
This cat is friendly	**X(s)**	**X(s)**	**X(s)**					

7.5.1 Main findings and questions raised

- A group of five items were identified as being some of the more fundamental trait aspects to owners, and along with several other measures were also associated with higher levels of owner post-adoption satisfaction.

- Interestingly, less satisfied individuals were not as easily identifiable via their ‘ideals’ or expectations as anticipated, with the results suggesting that level of post-adoption satisfaction may be more influenced by the specific behavioural responses of cats than by an owner’s prior level of expectation.

8 Chapter 8 – Discussion:

8.1 Outline of experimental methodology developed and research findings in relation to the primary aims (see Chapter 1) of the PhD.

Aim 1: *To assess individual differences relating to 'human sociability' in cats using a solid (neuro)biological framework.*

In accordance with the first aim of the PhD, the concept of human-sociability within the domestic cat was critically deconstructed (Chapter 1) into individual motivational-emotional traits that were anticipated to be important in the behavioural manifestation of sociable behavioural responses towards humans (these included; Sociability, Boldness, Gregariousness, Frustration reactivity, and Fearfulness). Using a relevant neurobiological framework, these traits were then mapped against the core emotional operating systems that were hypothesised to be of importance (e.g. FEAR, SEEKING and RAGE). A series of behavioural tests were then developed (Chapter 2) involving situational contingencies associated with the arousal of these emotional systems, across both social and physical contexts. Individual measures that could potentially be used to assess the behavioural tendencies of interest were then identified from each of the test contexts.

Aim 2: *Determine which of the identified behavioural measures were;*

1. *Valid and reliable indicators of traits relating to 'human sociability'.*
2. *Practical and feasible for use in the rehoming centre environment.*

The individual behavioural measures were then assessed for their initial reliability across short-term temporal and social gradients, in order to assess the general robustness of each test measure (Chapter 2). A total of 65 measures across the four separate tests were assessed, with many of these influenced by temporal and social factors in relatively complex ways. For example, various measures were influenced by the interaction between temporal effects and the familiarity of a person (either ‘familiar’ or ‘unfamiliar’), or the interaction between the familiarity of a person and their behavioural style (either ‘active’ or ‘passive’). At this point, the most reliable of the test measures (i.e. those that were not affected by short-term temporal effects or interactions of factors) were then retained and their further reduction explored in order to increase the practicality of test models (without affecting their ability to meaningfully differentiate between individuals based on aspects of human-sociability), another fundamental component of Aim 2. During this process, three of the four tests were removed, with only the Emergence Test (Test 3) retained; within this test a total of three behavioural measures across nine individual social conditions (i.e. reliable behavioural style/familiarity combinations for each measure) were retained within a final test model These measures are presented in summary format below (Table 8.1) for ease of reference. Such reduction in measures greatly increased the practicality of the test model because Test 3 was the test most easily executed without compromising the day to day running of the rehoming centre, as well as being the easiest experimental condition to control and standardise (it was performed away from the main cattery and from staff and visitors).

Table 8.1 List of initial refined behavioural measures retained in Chapter 2, their representation across each HCA cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster 1 contained behavioural measures that represented social RAGE, Cluster 2 measures of physical SEEKING and Cluster 3 social SEEKING.

<table>
<tr><th>Cluster 1 measures:</th><th>Emotional processes and context</th><th>Cluster 2 measures:</th><th>Emotional processes and context</th><th>Cluster 3 measures:</th><th>Emotional processes and context</th></tr>
<tr><td>Frequency of meows within the familiar person/passive interaction style condition</td><td>R(s)</td><td>Frequency of rubs on a person within the unfamiliar person/passive interaction style condition</td><td>S(p)</td><td>Frequency of approaches of a person within the familiar person/passive interaction style condition</td><td>S(s)</td></tr>
<tr><td>Frequency of meows within the familiar person/active interaction style condition</td><td>R(s)</td><td rowspan="3">Frequency of rubs on a person within the familiar person/passive interaction style condition</td><td rowspan="3">S(p)</td><td>Frequency of rubs on a person within the unfamiliar person/active interaction style condition</td><td>S(s)</td></tr>
<tr><td>Frequency of meows within the unfamiliar person/passive interaction style condition</td><td>R(s)</td><td rowspan="2">Frequency of rubs on a person within the unfamiliar person/passive interaction style condition</td><td rowspan="2">S(s)</td></tr>
<tr><td>Frequency of meows within the unfamiliar person/active interaction style condition</td><td>R(s)</td></tr>
<tr><td colspan="6">Interpretation of each cluster:</td></tr>
<tr><td colspan="2">RAGE:-(primarily in a social context)</td><td colspan="2">SEEKING:- (primarily a physical context)</td><td colspan="2">SEEKING (primarily in a social context)</td></tr>
</table>

At this point, the proposed model was put through a more rigorous assessment for validity and reliability on a larger population of cats across several different rehoming centres (Chapter 3). Individual behavioural measures were initially assessed for their longitudinal stability across the different social conditions (i.e. familiar/unfamiliar person and active/passive interaction style). During this process, several of the individual test conditions appeared longitudinally unreliable and were thus removed. The longitudinally reliable measures are summarised below (see Table 8.2) for ease of comparison between the two models (Table 8.1 and Table 8.2).

Table 8.2 List of longitudinally reliable measures identified in Chapter 3, their representation across each cluster, relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s), and the overall interpretation given for each cluster. Cluster sRB contained behavioural measures that represent social RAGE, whilst cluster s/pSB social and/or physical SEEKING.

<table>
<tr><th>sRB:</th><th>Emotional processes and context</th><th>s/pSB:</th><th>Emotional processes and context</th></tr>
<tr><td rowspan="2">Frequency of meows within the familiar person/active interaction style condition</td><td rowspan="2">R(s)</td><td>Frequency of approaches within the familiar person/passive interaction style condition</td><td>S(s/p)</td></tr>
<tr><td rowspan="3">Frequency of approaches within the unfamiliar person/passive interaction style condition</td><td rowspan="3">S(s/p)</td></tr>
<tr><td>Frequency of meows within the unfamiliar person/passive interaction style condition</td><td>R(s)</td></tr>
<tr><td>Frequency of meows within the unfamiliar person/active interaction style condition</td><td>R(s)</td></tr>
<tr><td colspan="4">Interpretation of each cluster:</td></tr>
<tr><td colspan="2">RAGE:-(primarily a social context)</td><td colspan="2">SEEKING (in a social and/or physical context)</td></tr>
</table>

At a group level, the model was then assessed for its reliability and structural stability (and thus generalizability) across the different physical locations (i.e. different centres). At this point, the frequency of ‘meows’ (representing three of the five remaining individual measures) were found to be differentially affected by location or social factor interactions (e.g. familiarity: interaction style: rehoming centre), and it was hypothesised that such location-specific effects could be due to differences in the affect and/or functional properties of the behavioural measures. Furthermore, with the removal of measures that were longitudinally unreliable, social and physical SEEKING were no longer differentiable based on the remaining two clusters of measures (sRB and s/pSB) (see Tables 8.1 and 8.2 for comparison), thus limiting the potential sensitivity of the test model regarding these aspects of emotional reactivity.

Such results indicated limitations in relation to aspects of the validity and generalizability of the test measures in their current form and highlighted the need to explore additional/alternative means of assessment. Other potential methods of trait assessment aimed at complementing the behavioural test approach (based on the same underpinning theoretical frame-work developed in Aim (1)) were thus explored (Chapter 4).

A questionnaire comprising of 28 individual items that could be used to assess behavioural aspects relating to the traits and underpinning emotional process of interest was developed, based around every-day types of human-cat interactions. It was designed to be filled in by members of rehoming staff working with cats. Data were collected across four different rehoming centres and each item within the questionnaire was assessed for its intra and inter-rater reliability, practicality, as well as longitudinal stability. Ten of the original 28 items were deemed sufficiently reliable across all aspects tested and were thus retained in a final questionnaire model (the ‘Lincoln Cat Assessment Test’ or L-CAT). As with the behavioural measures, these items were then clustered together to create several composite variables (sSQ, sFQ, sRQ), each representing aspects of the key emotional processes of interest. However, these were only represented in a primarily social and not physical context, suggesting that the social aspects of these processes (and their associated traits) may be easier to reliably assess in such environments than physical ones. The individual items and their respective clusters are summarised below for ease of reference (Table 8.3)

Table 8.3 The ten L-CAT items reliable within the rehoming environment and their place within each cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. Cluster sSQ contains questionnaire items that represent social SEEKING, cluster sRQ social RAGE, and cluster sFQ social FEAR.

Cluster sSQ	Emotional processes and context	**Cluster sRQ**	Emotional processes and context	**Cluster sFQ**	Emotional processes and context
Q7 This cat is vocal around people	S (s), R(s)	Q9 This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it	R(s) F(s)	Q2 This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks	F (s)
Q16 This cat likes being stroked	S (s)	Q19 I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)	R(s) F(s)	Q5 This cat is timid	F (s, p)
Q26 This cat is friendly	S (s)	Q20 When I am around this cat, it seems angry	R (s)	Q23 This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)	Behavioural stability
Q28 The temperament and	Rehomeability				

<table>
<tr><td>behavioural style of this cat will make it is easy to rehome</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Interpretation of each cluster:</td></tr>
<tr><td colspan="2">SEEKING (primarily a social context)</td><td>RAGE (primarily a social context)</td><td>FEAR (primarily a social context)</td></tr>
</table>

Next, the relationship between (and thus convergent validity) of refined behavioural test (Table 8.2) and questionnaire (L-CAT, Table 8.3) measures was assessed (Chapter 5, Part 1). The results suggested a level of convergent validity between higher social RAGE behaviour scores (sRB) and higher social SEEKING (sSQ) and social RAGE (sRQ) L-CAT cluster scores (as an interaction), (in keeping with current hypotheses – see Chapter 5), however when viewed independently, the inverse relationship between sRB and both sSQ and sRQ was demonstrated (higher sRB was associated with both *lower* sSQ and *lower* sRQ). In relation to s/pSB (social/physical SEEKING behaviour cluster), higher scores were associated with lower sFQ (social FEAR), but not sSQ (social SEEKING) L-CAT scores, suggesting that s/pSB measures may not be sensitive enough to differentiate between socially and physically mediated SEEKING behaviours within the test contexts, as was anticipated. Such results would suggest heterogeneous relationships between the behavioural and questionnaire measures that could ultimately depend upon variations in the affective and/or functional properties of behavioural responses within test contexts.

Additionally, the relationship between Handling Issues (HI) prior to behavioural testing and the L-CAT measures was assessed (Chapter 5, Part 2). The results indicated a significant relationship between the absence of HI and higher sSQ (social SEEKING) as well as lower sRQ (social RAGE) L-CAT scores, and no relationship between HI and sFQ (social FEAR) scores. Such results appeared more consistent with current hypotheses (i.e. that aggression may be mediated more by RAGE than FEAR), and also provided a more feasible method of assessment in comparison to the behavioural test measures.

The stability and predictive validity of measures collected within the rehoming centre in relation to future behaviour within the home were also assessed (Chapter 6, Part 1). Of the ten L-CAT items that were reliable within the rehoming environment, six of these were stable from rehoming centre to the home, suggesting that such individual measures can provide reliable information about the future responses of cats post-rehoming. The majority of reliable measures were associated with either social SEEKING or social FEAR, and half of all the measures related specifically to the responses of cats towards human handling, suggesting these types of measures are some of the most reliable between staff and owner ratings. In contrast, several of the unreliable measures were associated with social RAGE, suggesting that such measures may be the least reliable. As was done with the ten previous L-CAT items, the (refined) L-CAT items were then clustered together to create several composite variables, and interpreted in relation to the aspects of the key emotional processes of interest. This is outlined below in Table 8.4.

Table 8.4. The six (refined) L-CAT items reliable between the rehoming environment and the home and their place within each cluster, their relevance to primary emotional processes (R=RAGE, F=FEAR, S=SEEKING) in either physical (p) or social contexts (s) and the overall interpretation given to each cluster. Cluster sSQ contains questionnaire items that are hypothesised to represent social SEEKING and cluster sFQ social FEAR.

Cluster sSQ	Emotional processes and context	**Cluster sFQ**	Emotional processes and context
Q16 This cat likes being stroked	S (s)	Q2 This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks	F (s)
Q26 This cat is friendly	S (s)	Q5 This cat is timid	F (s, p)
		Q9 This cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it	F(S) R(s)
		Q23 This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly)	Behavioural stability
Interpretation of each cluster:			
SEEKING (primarily a **social** context)		FEAR (primarily a **social** context)	

The (refined) L-CAT clusters and behaviour measure clusters were then assessed for their predictive validity in relation to composite measures (factors) of adopter-reported behaviour (Chapter 6, Part 2). Unfortunately, the presence of handling issues (HI) during handling could not be included as a potential predictive measure due to limited post-adoption questionnaire responses collected from cats that displayed HI. Results however indicated no clear predictive relationship between the (refined) L-CAT clusters and behaviour measures (individually or in combination) and the factors relating to owner-reported post-adoption behaviour.

Thus, whilst the (refined) L-CAT items were predictive on an individual basis, as composite measures (i.e. the two clusters sSQ (social SEEKING) and sFQ (social FEAR), they were not able to predict the composite measure (factor) scores based on owner-rated items that were hypothesised to share the same theoretical underpinnings. This might be because so few items were actually reliable within the rehoming centre and between the rehoming centre and home (i.e. only six), and therefore the (refined) L-CAT clusters contained only a very small amount of the total items included in the owner-rated factors, potentially limiting their ability to fully represent the factor-based constructs identified.

Aim 2 conclusions:

These results have established that the overall construct validity of the behavioural test measures in the assessment of traits relating to aspects of human-sociability is limited. Additionally, predictive validity of such measures in relation to future post-rehoming behaviour was poor. When exploring alternative methods of behavioural assessment, many of the questionnaire items developed were also found to vary considerably either within the same, or between different raters, as well as over time. Such measures thus cannot be used reliably to assess the behavioural traits of interest within cats, and highlight a fundamental issue within the general field of temperament assessment, where measures are often used without their reliability or validity first being thoroughly established, ultimately raising the question of their general utility as a form of temperament test.

A total of ten questionnaire items (the L-CAT) *were* reliable within the rehoming environment, and also demonstrated a level of convergent validity with other types of measures (i.e. handling issues), as well as content validity in relation to their representation of the range of core emotional processes of interest (i.e. FEAR, SEEKING and RAGE) (although only in a social capacity). These measures could thus potentially be used to practically identify cats with different behavioural tendencies, and assist in the assessment and management of individuals within the rehoming environment.

In addition, a smaller subset of six items were also found to be reliable between the rehoming centre and the home. These (refined) L-CAT items could provide prospective owners with useful information about how the cat is likely to respond in future situations, particularly in relation to human interaction and handling, with the caveat that behavioural responses relating to frustration reactivity (i.e. RAGE) cannot be reliably predicted. These measures could form the basis for matching adopters with suitable cats, by using the (refined) L-CAT scores and corresponding owner 'ideal' ratings.

Aim 3: Assess factors relevant to owner 'satisfaction' post-adoption.

The (refined) L-CAT and behavioural measure cluster scores were assessed for their ability to predict composite measures of owner-reported satisfaction (Chapter 6, Part 2). No significant predictive relationships for any of either the (refined) L-CAT or behaviour measure clusters (individually or in combination) versus total owner satisfaction scores were found. When assessed as individual measures, again there was no significant predictive relationship between any of the six (refined) L-CAT items (as single items or in combination) and satisfaction scores. In light of these results, owner satisfaction was explored further in relation to owner 'ideals' or expectations of behaviours, and the most important behavioural aspects potentially relevant to satisfaction (Chapter 7).

Pre-adoption 'ideals' and post-adoption 'actual' ratings of owners were therefore compared. Items that were most consistent between the two (suggesting these traits are potentially the most fundamental) were identified. Two of these items were also represented within the (refined) L-CAT items (those indicated in bold below):

- I'd like a cat that would prefer to be with people than be left alone

- **I want a cat that likes being stroked**
- I'd like a cat that will come and ask me for attention and initiate contact with me (e.g. a cat that will come and sit on my knee, or rub up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)
- **I'd like a cat that won't try to avoid me when I go to stroke it or tickle its chin/cheeks**
- I don't want a cat that seems fearful

Further analyses comparing post-adoption ratings of behaviour based on levels of satisfaction suggested that such traits are potentially not only important to owners but also associated with higher levels of satisfaction.

Interestingly, five of the (refined) L-CAT items were also amongst those that were rated most highly by more satisfied people. As such, they could be used to contribute towards reliably gauging potential post-adoption satisfaction (in relation to these specific behavioural tendencies). The following fifteen items were those that featured most prominently in relation to higher satisfaction scores (in order of relative effect size). Items in bold represent those that corresponded with the five (refined) L-CAT items.

- My cat is very tolerant to being handled
- **My cat is friendly**
- My cat doesn't try to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)
- My cat is quick to settle and adapt to change
- When I initiate contact or interaction with my cat, it doesn't move away and is instead responsive towards me (i.e. purrs or rubs up against me)
- **My cat likes being stroked**
- **My cat doesn't try to avoid me when I go to stroke it or tickle its chin/cheeks**
- My cat comes and asks me for attention and initiates contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)

- My cat would prefer to be with people than be left alone
- Never avoid stroking due to worry of aggression
- My cat is comfortable being picked up
- My cat is playful
- **My cat is not timid**
- **My cat doesn’t behave aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it**
- My cat is not fearful

Aim 3 conclusions:

The behavioural cluster measures were not able to predict composite scores relating to owner satisfaction, however neither were any of the (refined) L-CAT cluster measures nor individual L-CAT items, potentially because only two of the these items featured amongst those that were identified as being the most ‘fundamental’ to owners (i.e. consistent between ‘ideal’ and ‘actual’ ratings, see the above list). However, five of the six (refined) L-CAT items *were* rated significantly higher/more positively by more satisfied people, and whilst such items may not fully represent the suite of behavioural traits or factors that influence ‘total satisfaction’ (perhaps particularly because RAGE was no longer represented by items in the (refined) L-CAT), they may be individually important contributors, which *can* be reliably predicted post-adoption.

8.2 Summary:

A range of basic behavioural and questionnaire measures designed to assess aspects of human-sociability that shared the same underpinning neurobiological framework were developed and assessed for their validity, reliability and practicality for use in an applied setting (the rehoming environment). A substantial proportion of the measures assessed were however unreliable, suggesting that many of the behavioural responses that are easily observable in such environments may not actually present useful measures in the identification of certain behavioural tendencies within cats (i.e. those relating to human-sociability), or may require test conditions that are not practically reproducible. Such unreliability was present both at the directly observable level (i.e. behavioural responses were influenced by the temporal, social and environmental context), as well as the more subjective level based on human inferences (i.e. ratings varied over time and also within and between observers).

Whilst the final set of behavioural test measures developed were initially reliable *within* individuals, their generalizability *across* separate locations/populations was restricted due to the existence of several social context-location specific effects. Furthermore, such measures did not clearly predict owner reports of behaviour post adoption, even with the effect of location taken into consideration. This ultimately highlights the issue of using gross behavioural measures in the assessment of complex behavioural constructs that exist at the latent or concept level, and which are thus inherently difficult to measure directly (e.g. see Taylor and Mills 2006, Stamps & Groothuis 2010, Carter *et al* 2013). This is perhaps particularly difficult where individuals are assessed in one specific type of environment that may often be quite challenging or stressful (e.g. see Kessler and Turner 1999a, 1999b, Ottoway and Hawkins 2003, Gourkow and Fraser 2006, Uetake *et al* 2012) and also not representative of a ‘typical’ home or intended future environment (Taylor and Mills 2006).

These findings also have important implications in relation to previous studies that have used similar types of behavioural assessment techniques but have not applied the same level of scrutiny regarding their reliability and validity. Because the experiments performed within this thesis demonstrated a high level of unreliability for many of the measures assessed, where the reliability of measures in previous studies has *not* been properly demonstrated (as has been the case with the majority of previous tests - see Lee *et al* 1983, Meier and Turner 1985, Feaver *et al* 1986, Turner *et al* 1986, Reisner *et al* 1994, Bradshaw and Cook 1996, Gosling & Bonnenburg 1998, Lowe and Bradshaw 2001, Siegford *et al* 2003, Lee *et al* 2007, Wedl *et al* 2011, Slater *et al* 2013a-c, Gartner *et al* 2014), the general construct validity and utility of such tests is questionable, because ultimately they may not provide useful information about the actual temperament of the cat.

Since the results of such tests may not only influence the way the individual is managed within the current place of assessment (e.g. McCune 1992, Hawkins 2005, Kessler and Turner 1997, Van den Bos 1998), but also the type of future environment they are then placed into (Lee *et al* 1983, Seigford *et al* 2003, Slater *et al* 2013), unreliable information may lead to less than optimal management of and outcomes for an individual, and as a consequence a (potentially avoidable) compromise to their welfare.

In contrast to the general findings regarding the behavioural test measures, a refined set of questionnaire items (the L-CAT), were however found to provide both a highly practical and robust form of behavioural assessment. Such measures are very quick and safe to perform and do not require manipulation of the cat in any way, thus being efficient and avoiding the potential for negative arousal that may occur in certain cats during physical handling. The questionnaire items were reliable within and between different raters and over time and also demonstrated aspects of convergent validity with other types of measures. Such factors make these measures particularly suited to the rehoming environment where resources are generally restricted (e.g. see Clark *et al* 2012, Stavisky *et al* 2012) but staff safety and cat stress-management (e.g. Rochlitz 1999, Gourkow and Fraser 2006, Kry and Casey 2007) are considered important. In their application, these assessments could be used to facilitate the rapid identification of the most suitable type of management and interventions for each cat on an individual basis.

In addition, a smaller subset of the L-CAT measures (the (refined) L-CAT) were also individually predictive of future owner-reported behaviour within the home post-adoption, as well as being associated with higher owner-satisfaction (bar one item). Such measures could thus be used to provide potential owners with reliable information regarding the likely behavioural tendencies of cats in the home context (thus managing their expectations) as well as to match cats with the most suitable owners. However, unlike the L-CAT that contained measures representing all social aspects of the original ‘human-sociability’ theoretical model (i.e. SEEKING, FEAR and RAGE, see Chapters 1 and 4), the (refined) L-CAT no longer contained measures hypothesised to relate to RAGE, (see Chapter 6), thus limiting the content validity of this model.

Whilst the predictive validity of the presence of Handling Issues (HI) in relation to adopter reports of behaviour could not be assessed within this study (due to insufficient sample sizes), a further investigation of its predictive potential might help to enhance the current content validity of the (refined) L-CAT in relation to social RAGE, if indeed the presence of HI was found to be predictive of higher social RAGE scores within the home (as it was with social RAGE scores in the rehoming centre).

Whilst five of the six items within the (refined) L-CAT model were associated with increased owner satisfaction, interestingly they did not predict absolute satisfaction levels, and such results might suggest that other aspects of the cats' behaviour that cannot be practically measured or reliably predicted (within a rehoming environment) may be important factors in relation to satisfaction.

It is also possible that the individual attributes of owners (such as levels of owner attachment or 'personality types', e.g. see Serpell 1996, Stammbach & Turner 1999, Wedl *et al* 2011, Curb *et al* 2013) might add an extra important dimension to the understanding of factors relevant to adopter satisfaction, and thus could potentially be used in combination with items from the (refined) L-CAT model, in order to enhance its predictive validity in relation to post-adoption satisfaction.

8.3 Limitations of the approach used to assess behavioural tendency in cats in rehoming centres

8.3.1 Theoretical and methodological approach:

The use of an affective 'natural kinds' model for the study of behavioural tendency within cats was to a certain extent a useful tool in the test development, measure refinement and interpretation process, particularly when data analysis methods such as HCA (which require a suitable theoretical framework to ensure adequate scientific rigour) were employed.

However, the attempt to classify behavioural measures not only in relation to their underlying emotion process, but also in relation to their links with either 'social' or 'physical' stimuli potentially created a model that was too complex, considering the simplistic nature of the behavioural test measures that were selected, and the fact that in some cases measures were theorised to potentially relate to more than one emotional process, and sometimes both social or physical stimuli. As such, in some cases, there was ambiguity in relation to the 'correct' interpretation of measures and their clusters, and this is thought to be the reason why the convergent and criterion validity of the test model was so poor. The use of the chosen behavioural measures in combination with the theoretical framework used is therefore not considered to have worked well in relation to the assessment of the traits of interest with the rehoming centre.

The theoretical approach also worked well for the development, refinement and interpretation of the questionnaire model, and in contrast to the behavioural test measures, the reliability, convergent and criterion validity of this model was considered to be good. However, many of the questionnaire items were also unreliable, and it is suggested that where descriptive terms such as 'friendly', 'fearful', 'timid' and 'angry' were used, their standardisation between raters (for example using an FCP/spontaneous behaviour approach) could have been performed, and may have helped to improve reliability.

Chapter 7 highlighted various behavioural tendencies as being more important and linked to greater satisfaction than others. Whilst many of these were represented within the L-CAT, in hindsight, the findings within this study could have provided a very useful starting point from which a behavioural assessment model could then have been built. This approach may have helped to better consolidate the preferences and potential satisfaction of owners within the type of assessment tools developed.

8.3.2 Statistical approach:

Several limitations in relation to the HCA approach used in Chapters 2 & 3 have been identified. During the model refinement process, a substantial amount of individual behavioural measures were initially discarded for practical reasons (rather than their relative quality), and it's possible that some of these *could* have provided a reliable addition to the final model that was developed. The decision to remove these measures was therefore potentially done so in haste. This initial removal of measures also substantially changed the nature of subsequent clustering of remaining items within the dendrogram (an inherent issue associated with the HCA method) and thus the interpretation that was given to each cluster. Alternatives to HCA (such as ‘Convex clustering’ (see Chen *et al* 2015)) that are potentially able to offer a more structurally robust method of clustering could have been a better statistical method to use.

Whilst dendrograms were cut at points where doing so created clusters that made biological sense in relation to the theoretical framework, this was done via visual inspection of the dendrograms, and in retrospect, a more standardised approach to dendrogram ‘cutting’ could have been utilised. For example, there are methods that facilitate multiscale bootstrap resampling which provide p values for each cluster to identify those that are highly supported by the data (see Suzuki & Shimodaira 2006). In addition, different cluster formations or solutions can be compared using specific validation criteria in order to select the optimal division of clusters. And finally, when specific cutting points are determined, they can be done computationally rather than manually, avoiding human error.

8.4 Potential application of the test measures developed:

See Figures 8.1-8.3 and Tables 8.5-8.12 for all supplementary assessment materials.

8.4.1 Behavioural profiles:

Using a combination of L-CAT cluster scores, several different provisional behavioural profiles relevant to aspects of human-sociability and the aggressive response within the rehoming environment were identified. These profiles are discussed with regard to cat-human interactions and relationships. Descriptive statistics (i.e. maximum, minimum, mean and median scores along with the standard deviation and inter-quartile ranges) are provided for each cluster (sSQ, sRQ and sFQ) from which relative scores could be determined (e.g. high, medium, low) - see Table 8.5).

(i) **Cats high in social SEEKING (sSQ) but low in social RAGE (sRQ) and also social FEAR sFQ).**

Such cats are likely to appear gregarious. They may be keen to interact with people on a regular basis and to initiate such contact. They may also be the types of individuals least likely to behave aggressively towards humans during interactions. These cats may potentially be well suited to domestic living alongside humans, as a social companion.

(ii) **Cats high in social SEEKING (sSQ) but also social RAGE (sRQ).**

These individuals may also appear gregarious and keen to interact (and initiate interactions) with people on a regular basis, but perhaps for shorter periods of time than profile (i) cats. They may also be more likely to behave aggressively towards humans during such social interactions. Such cats may potentially be suited to domestic living alongside humans as a social companion, although careful management of the environment as well as cat-human interactions (that avoid exceeding the cat's tolerance threshold) may be necessary in order to avoid human-directed frustration and aggressive behaviour.

(iii) **Cats high in social SEEKING (sSQ) but also high in social FEAR (sFQ).**

These individuals may appear sociable but not very bold. They may be keen to interact with people but may be less likely to initiate such interaction regularly. These cats may also be less likely to interact with unfamiliar people and may instead choose to hide or keep themselves at a distance when in their presence. Such cats may potentially be suited to domestic living alongside humans as a social companion, but careful management of the environment and controlled interactions (that avoid inducing fearful behavioural responses and stimulus flooding of the cat) and may be necessary.

(iv) **Cats low in social SEEKING (sSQ) but high in social RAGE (sRQ).**

These individuals may appear unsociable and high in frustration reactivity. They may be likely to avoid all human contact and interaction and behave aggressively when in the close proximity of humans, or where the person tries to initiate contact. Such cats are potentially unsuited to domestic living alongside humans as a social companion.

(v) **Cats low in social SEEKING (sSQ) and also low in social RAGE (sRQ) and social FEAR (sFQ).**

These individuals may or may not appear particularly *unsociable*, but are unlikely to initiate social interaction with humans, although they may tolerate human presence and potentially some (limited) form of contact if food or other resources are provided. These cats are potentially unsuited to domestic living alongside humans as a social companion.

(vi) **Cats low in social SEEKING (sSQ) but high in social FEAR (sFQ).**

These individuals may appear unsociable and also fearful. They may be likely to avoid all human contact and interaction and may either try to escape when in close proximity of, or where contact is initiated by, a person. In situations where escape in not possible, such cats may ‘freeze’ and in some cases behave aggressively towards the person. These cats are potentially unsuited to domestic living alongside humans as a social companion.

Table 8.5 Descriptive statistics for individual L-CAT scores for each cluster (sSQ - social SEEKING, sRQ – social RAGE and sFQ – social FEAR). Clusters comprised of ten questionnaire items rated by rehoming staff members in relation to the cats' behaviour, which were reliable within the rehoming centre environment (see Table 8.3). Maximum, minimum, mean and median scores along with the Standard Deviation and Inter-Quartile Ranges are displayed (to the nearest whole number).

Cat L-CAT cluster scores	**sSQ (social SEEKING cluster scores)**	**sRQ (social RAGE cluster scores)**	**sFQ (social FEAR cluster scores)**
Minimum	5	3	3
Maximum	20	15	14
Mean	14	4	8
Median	14	3	8
Standard Deviation (SD)	3	2	2
Inter-Quartile Range (IQR)	3	2	4

8.4.2 In-situ management and behavioural intervention/modification:

Using the framework and the suitably reliable and valid measures developed during this thesis may be particularly helpful in the application of more individual-specific management and interventions, because motivational states of affect (i.e. FEAR, SEEKING and RAGE) are considered as independent but interactive factors, and in relation to their social as well as physical (although these could not be practically/reliably predicted) components. For example, in relation to aversive responses towards people, a cat that is potentially sociable (i.e. high social SEEKING) but also high is social frustration reactivity (i.e. social RAGE) - Profile (ii) cats, would benefit from very different management and interventions to a cat that is potentially sociable (high social SEEKING) but that is also fearful (i.e. high social FEAR) - Profile (iii) cats, and again different to a cat that is not inherently sociable (i.e. low social SEEKING) but that is also high in frustration reactivity (i.e. high social RAGE) - Profile (v) cats. Such behavioural information could thus be used to identify the most suitable ways these different types of individuals are handled and interacted with, as well as the type of environmental provisions they receive. The following section discusses the various ways in which the identified profiles might be used to provide more individual-specific management strategies for rehoming centre cats, in order to optimise their welfare. These should be considered hypotheses to be tested.

8.4.2.1 Environmental management:

Enrichment/management strategies for fearful cats (e.g. Profile (iii) and (iv)) could include 'increased security of floor space' (i.e. hiding places, see Carlstead *et al* 1993, Kry & Casey 2007, Moore & Bain 2013, Vinke *et al* 2014), more predictable routines and handling (see Carlstead *et al* 1993, Gourkow & Fraser 2006) and pheromone therapy (e.g. see Frank *et al* 2010), whilst for frustrated cats (e.g. Profiles (ii and v)) feeding enrichment and various forms of sensory stimulation may be most appropriate (see Ellis 2009). In addition, for cats identified as being more likely to experience states of negative affect (such as FEAR or RAGE), (i.e. Profiles (ii-vi)) managing the general stress levels of the individual and promoting habituation to the rehoming environment (e.g. minimal disturbance, provision of suitable resources, single housing for cats unsocialised to conspecifics etc., see Finka *et al* 2014), may also be particularly beneficial to their general wellbeing whilst in the rehoming centre.

8.4.2.2 Cat-Human interaction and human-directed aggression:

The level of sociability of the cat (i.e. social SEEKING scores) could also be used to determine the most suitable or appropriate types and amounts of 'social enrichment' for the cat (e.g. Ellis 2009). For example unsociable cats (e.g. those scoring low for social SEEKING - profiles (iv-vi)) may ultimately find handling and human presence particularly aversive, which should thus be kept to a minimum, whilst cats with high social SEEKING scores (i.e. Profiles (i-iii)) may benefit from frequent human-interactions and physical contact (particularly cats high in social SEEKING and low social RAGE and FEAR – e.g. profile (i))

However, if cats are high in both social SEEKING *and* RAGE (e.g. Profile (ii)), they may need more careful or controlled interactions to avoid over arousal/stimulation, as would Profile (iii) cats (those high in social SEEKING *and* FEAR) to avoid overwhelming or stimulus flooding of the individual (for a definition of this term see Mills & Marchant-Forde 2010, pages 268-269).

Such behavioural assessments may also help specifically in the management of human-directed aggression during handling or interactions, which may vary depending upon the underpinning motivational states of affect that are likely to be associated with the aggressive response. For example (otherwise sociable) cats that have behaved aggressively in a specific context but are also fearful (i.e. potentially profile (iii) cats (high social SEEKING and FEAR) could be managed with increased distances away from the human during initial interactions (Frank & Dehasse 2004) and counter - conditioning/desensitisation programmes (CC/DS). In contrast, sociable cats that are not fearful, but that have behaved aggressively during physical contact on occasion (i.e. potentially particularly profile (ii) cats - high social SEEKING and RAGE), may be optimally managed through increased handler awareness of the areas most sensitive or likely to trigger an aversive or aggressive response (e.g. see Ellis *et al* 2014) so that handling tolerance thresholds are not exceeded (see Chapman 1991, Palacio *et al* 2007, Curtis 2008, Ramos and Mills 2009) and negative states of arousal are not induced.

8.4.2.3 Intervention priority and welfare-based outcomes:

Such assessments can also be used as a tool to help identify individuals that may be of higher welfare concern, thus prioritising cats that require more swift interventions to avoid outcomes that might be detrimental to their welfare. Certain types of individuals (for example cats generally low in sociability, (i.e. Profiles (iv-vi), (but particularly those also either high in frustration reactivity (i.e. Profile (v) or high in fearfulness (i.e. Profile (iv)) could find a rehoming environment and/or living alongside humans post-adoption stressful. Such cats may not cope well with the frequent presence of humans and the restriction of movement/containment that is usually associated with a rehoming environment, and it is thus important that they are not housed in a centre for unnecessarily long periods of time. In addition however, because these types of cats may also not cope well living as a social companion for humans, they should not be entered into the general ‘rehoming population’ either. These types of individuals may be better suited to environments where humans provide a basic level of care, but where the cat is able to move freely and avoid direct human-contact and interaction if they choose (for example food and shelter is provided for the cat in a farm or other type of outbuilding).

8.4.3 Ex-situ placement for cats suitable for domestic/social environments:

8.4.3.1 Gauging responses towards handling:

On an individual basis, (refined) L-CAT items q2 (whether the cat is avoidant when stroked), q16 (whether the cat likes being stroked) and q9 (if the cat behaves aggressively when stroked) could be used to gauge how the cat is likely to respond towards humans during physical handling and interactions. Such information may not only help match individuals with owners that are most suitable (in relation to the type and frequency of interaction they expect from a cat), but again also reduce the incidence of human-directed aggression, because the general level of handling the cat is thus likely to be exposed to (following a successful match) may reduce the chance of its tolerance limits being exceed (e.g. see Chapman 1991, Palacio *et al* 2007, Curtis 2008, Ramos and Mills 2009). A reduced incidence of such aggressive responses might not only reduce the risk of relinquishment (e.g. Salman *et al* 2000, Amat *et al* 2009), but also help to avoid the perceived ‘need’ for interventions that are potentially detrimental to the welfare of the cat (for example permanent surgical procedures such as de-clawing and ‘dental disarming’, where these procedures are still permitted (e.g. see Kakuma *et al* 2005)). Additionally, providing owners with information about how the cat is likely to behave in future contexts may also help to better manage owner expectations, and could potentially help to avoid low satisfaction as a consequence of expectations that are unrealistic (see Patronek *et al* 1996).

8.4.3.2 Environmental management:

As within the rehoming environment, cats with higher (refined) L-CAT sFQ(r) scores may particularly benefit from a generally quiet post-rehoming environment with predictable routines (Gourkow & Fraser 2006) and numerous hiding places (e.g. see, (see Carlstead *et al* 1993, Rochlitz 2005, Kry & Casey 2007, Moore & Bain 2013, Vinke *et al* 2014) and continued CC/DS towards humans (e.g. see Beaver 2004, Frank & Dehasse 2004, Kakuma *et al* 2005).

Whilst several of the measures hypothesised to relate to social frustration reactivity (i.e. RAGE) were not reliable between the rehoming centre and home, their reliable assessment *within* the rehoming centre (i.e. L-CAT sRQ score) *could* highlight where extra time educating the adopters about such cats (i.e. how to provide suitable environmental stimulation and appropriate types of handling), could be beneficial and provide preventative management for future potential frustration-based behavioural problems.

8.4.3.3 Cat and owner matching:

Additionally, clusters of measures from the (refined) L-CAT model (the five items associated with higher post-adoption satisfaction, now to be referred to as L-CAT(c)) could be used to score both cats and prospective owners, (using corresponding items from the ‘ideal’ QA.2 questionnaire, see Chapter 7, now referred to as L-CAT(o)), so that cat and owner could be most suitably matched based on their relative social SEEKING (sSQ) and social FEAR (sFQ) scores (e.g. cats with higher sFQ(c) scores are not matched with owners with low ‘ideal’ sFQ(o) scores, and cats with lower sSQ(c) not matched with owners with high ‘ideal’ sSQ(o) scores etc.). Descriptive statistics (containing the inter-quartile range, mean, standard deviation and median) are provided for each cat cluster (i.e. L-CAT(c) sSQ and sFQ) and owner ideal cluster (i.e. L-CAT(o) SQ and sFQ) from which relative scores (i.e. high, medium, low), could potentially be determined (See Tables 8.6 and 8.7).

Table 8.6 Descriptive statistics for individual L-CAT(c) scores for each cluster (sSQ(c) - social SEEKING, and sFQ(c) – social FEAR). Clusters comprised of five questionnaire items rated by rehoming staff members in relation to the cats' behaviour that were reliable between the rehoming centre environment and the home and were also associated with higher post-adoption satisfaction. Maximum, minimum, mean and median scores along with the Standard Deviation and Inter-Quartile Ranges are displayed (to the nearest whole number).

L-CAT (c) Cat behaviour ratings:	sSQ(c) (social SEEKING cluster scores)	sFQ(c) (social FEAR cluster scores)
Minimum	3	3
Maximum	10	15
Mean	8	6
Median	8	6
Standard Deviation (SD)	1	2
Inter-Quartile Range (IQR)	1	3

Table 8.7 Descriptive statistics for individual 'owner ideal' L-CAT(o) scores for each cluster (sSQ(o) - social SEEKING, and sFQ(o) – social FEAR). Clusters comprised of five questionnaire items rated by prospective adopters based on their 'ideals' (clusters correspond to those in Table 8.6). Maximum, minimum, mean and median scores along with the standard deviation and inter-quartile ranges are displayed (to the nearest whole number).

L-CAT (o) Owner 'ideal' ratings	sSQ(o) (social SEEKING cluster scores)	sFQ(o) (social FEAR cluster scores)
Minimum	4	3
Maximum	10	13
Mean	8	6
Median	8	6
Standard Deviation (SD)	1	2
Inter-Quartile Range (IQR)	2	2

8.4.3.4 A proposed framework for the assessment, management and owner-matching of cats within the rehoming centre environment:

This work has resulted in the ability to reliably and practically assess behavioural tendencies relating to aspects of human sociability in cats within the rehoming centre environment, using measures that have been (i) carefully developed using a suitable neurobiological framework and (ii) rigorously assessed for their reliability, validity and practicality in a way that has been previously neglected from tests designed to measure similar constructs (e.g. Lee *et al* 1983, Meier and Turner 1985, Feaver *et al* 1986, Turner *et al* 1986, Reisner *et al* 1994, Bradshaw and Cook 1996, Gosling & Bonnenburg 1998, Lowe and Bradshaw 2001, Siegford *et al* 2003, Lee *et al* 2007, Wedl *et al* 2011, Slater *et al* 2013b, Gartner *et al* 2014).

Not only did the process of measure refinement help to improve the reliability of the tests, it also facilitated their more practical application for use in environments such as the rehoming centre, thus providing a final test model high in general utility.

In their application, the information generated via the final test models can be applied in a way that can help to identify appropriate management strategies /interventions aimed towards improving the welfare of individual cats, as well as achieving better post rehoming centre outcomes, at a practical level. In order to demonstrate the practical application of the tests developed within the rehoming centre context, the proposed behavioural profiles (based on potential combinations of L-CAT scores) have been incorporated into a flowchart and Table and are presented along with other supplementary material (i.e. L-CAT assessment questionnaires and scoring sheets) (see Figures 8.1-8.3 and Tables 8.8 -8.12) providing a comprehensive assessment tool. This assessment tool will now be referred to as the ‘Lincoln Rehoming Centre Cat Assessment Tool’ (L-RCAT), to distinguish it from the L-CAT that refers only to the questionnaire items reliable within the rehoming environment used to create cluster scores.

8.4.3.4.1 Cat profiling using the L-CAT questionnaire:

It is suggested that the L-CAT (items that were reliable *within* the rehoming environment) should primarily be used to provide an assessment of the cat for the purposes of management and appropriate interventions within the rehoming centre, as well as determine a cats' rehoming potential (i.e. is the cat suitable to be a social companion for humans or not). A member of staff (that has fed, cleaned and socialised with a specific cat for at least seven days) should complete the L-CAT questionnaire (Figure 8.2), which is then used to create a series of L-CAT cluster scores and identify relevant cat profiles using the L-CAT scoring sheet (Table 8.8) and management guide (Table 8.9). In order to avoid any potential bias during scoring and profiling, it is suggested that these procedures are performed by another member of staff not familiar with the cat being assessed.

8.4.3.4.2 Cat-owner matching using L-CAT (c) and corresponding owner 'ideals' L-CAT (o):

The L-CAT(c) items (those that were reliable *between* the rehoming centre and home and were also associated with higher post-adoption satisfaction) could be used in order to match cats with suitable owners, based on relative sFQ and sSQ scores for both cat and owner. Relevant L-CAT(c) items for cats can be taken from a completed L-CAT questionnaire (Figure 8.2) and clusters then calculated using the L-CAT (c) scoring sheet (Table 8.10). To obtain L-CAT (o) items, prospective cat owners will be required to fill in an 'ideal cat' questionnaire (the L-CAT (o) Questionnaire (see Figure 8.3)) prior to meeting or selecting any cats. L-CAT (o) cluster scores can then be generated using the L-CAT (o) scoring sheet (Table 8.11). Finally, Tables 8.9 and 8.12 can be used to determine which types of owners may or may not be suitable for a specific cat, based on relative L-CAT (c) and L-CAT (o) cluster scores.

8.4.3.4.3 Current limitations of the cat-owner matching process:

Only social SEEKING and FEAR clusters were represented within the (refined) L-CAT (RAGE was not reliable between centre and home), thus matching is ultimately focused on these two emotional predispositions. However, if a cat *did* score highly for social RAGE (sRQ) on the L-CAT, such information *could* potentially also be used as a 'cautionary' factor in the matching of owners with cats. Whether in-situ L-CAT sRQ scores could be used as an effective tool in the cat-owner matching and education process should be explored during future follow-up work (see 'Further work' section 8.5).

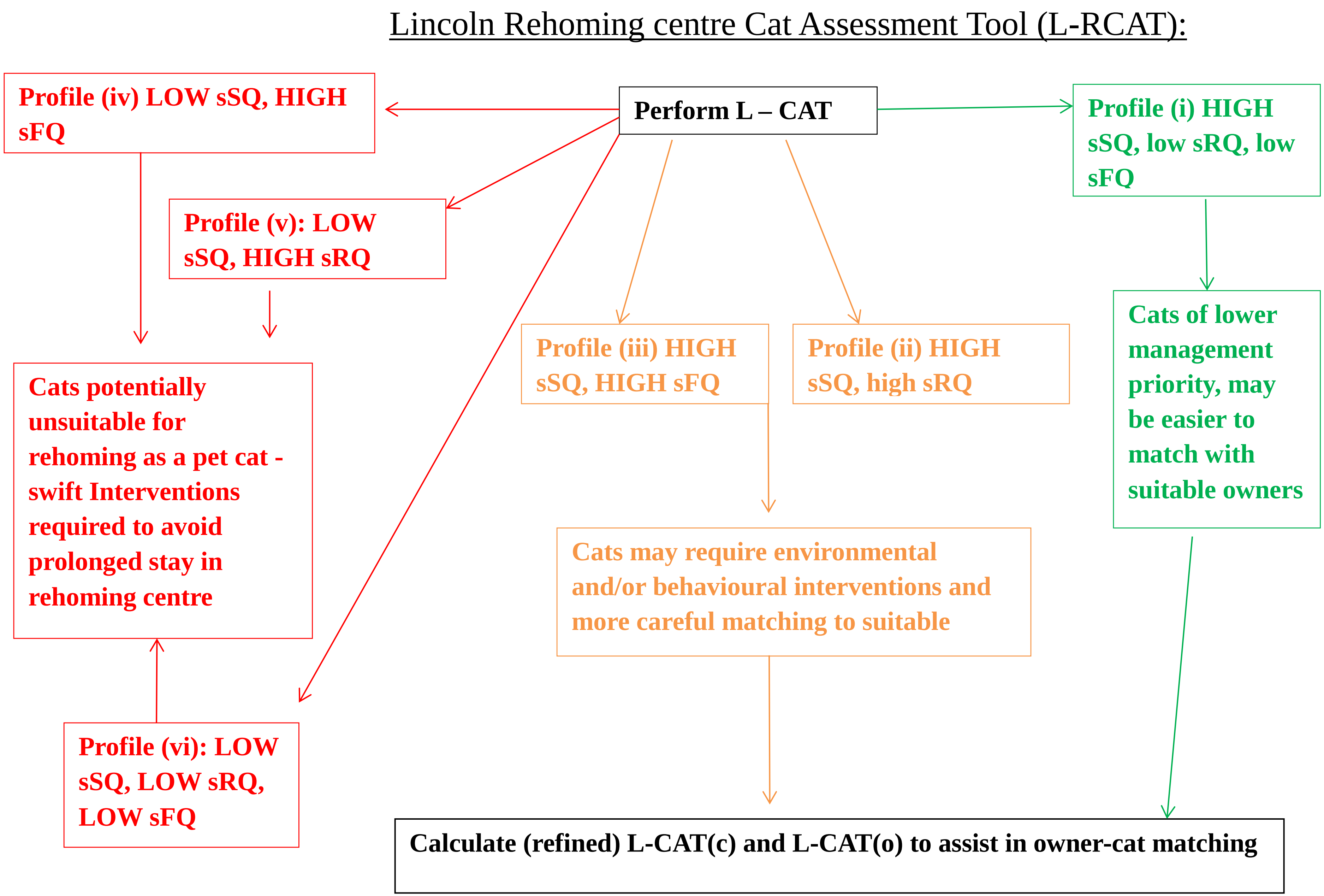

Figure 8.1 Flow chart to represent an overview of the assessment process using the Lincoln rehoming centre cat assessment tool (L-RCAT). Assessments are based on information from the L-CAT and the L-CAT subsets; L-CAT (c) (cat version) and L-CAT (o) (owner version) to identify different potential cat profiles (see section 8.5.1 for descriptions), the potential need for environmental and/or behavioural interventions within the rehoming environment (those of the highest intervention priority (red), moderate priority (yellow) and lower priority (green)) and also relevant potential rehoming outcomes.

Table 8.8 The L-CAT scoring sheet containing items reliable within the rehoming environment, used to create the identified behavioural profiles in relation to social SEEKING (sSQ), social RAGE (sRQ) and social FEAR (sFQ) cluster scores (see Profiles (i-vi) in section 8.5.1). Scores are generated based on the Lincoln Cat Assessment Test (L-CAT) questionnaire (Figure 8.9). Items on the questionnaire are scored from (1 to 5) left to right hand side from the L-CAT. Items with an (R) next to them are then reversed prior to cluster score calculation. Boxes are provided to impute the total cluster scores and select whether the score is ‘High’, ‘Medium’ and ‘Low’ based on the ranges indicated.

Score answers from left to right 1=far left 5= far right on the L-CAT Questionnaire. Reverse the scores for items with an (R) next to them. NB: *Ensure scoring is done by someone other than the person filling out the L-CAT	Question score:			
1. This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:				
2. This cat is timid:	(R)			
3. This cat is vocal around people :				
4. This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it :				
5. This cat likes being stroked :	(R)			
6. I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws):				
7. When I am around this cat, it seems angry :		sSQ Score: (3+5+9+10)	sRQ Score: (4+6+7)	sFQ Score: (1+2+8)
8. This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly):	(R)	/20	/15	/15
9. This cat is friendly :	(R)	❑ High ❑ Med ❑ Low	❑ High ❑ Med ❑ Low	❑ High ❑ Med ❑ Low
10. The temperament and behavioural style of this cat will make it is easy to rehome:	(R)			

Figure 8.2 The Lincoln Cat Assessment Test (L-CAT). Questionnaire containing items found to be reliable *within* the rehoming environment. To be filled out by staff that have been working with (i.e. feeding/cleaning/socialising) a cat for at least seven days prior to questionnaire completion. L-CAT items to be used to 'profile' cats primarily for management within the rehoming environment, and the L-CAT(c) items for the purposes of cat-owner matching (e.g. see Table 8.10).

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Lincoln Cat Assessment Test (L-CAT)

Instructions to rehoming staff:

Please enter the Cats details below:

1. Name:……………………………………………….

2. I.D number:……………………………………………..

3. Age:…………………………………………….

4. Colour: ………………………………………………..

5. Breed (please tick): **DSH:** ☐ **DSLH:** ☐ **DLH:** ☐

   Pedigree: ☐ (Please specify which breed)

   ……………………………………………………………………………

6. Sex**: Male / Female**

7. Neuter status: **Neutered / Unneutered / Unknown** ?

8. Date of arrival to shelter: __ __ /__ __ /__ __

9. Medical/health issues known about:

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

10. Any behavioural issues identified (either by you or any other members of staff)?

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

Questionnaire instructions:

- Depending upon the specific question, please indicate either how much or little you agree with a particular statement, or how often the situation described has occurred. Please answer all questions by circling the response that is most appropriate, and circle ONLY ONE response per question if you are unsure of an answer to a question, please circle the 'Unsure' option.

E.g.: Q1. This cat likes being groomed:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

- Please do not fill in this questionnaire at a time when you are directly interacting with the cat.

Questions:

1. **This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:**

Never Once Occasionally Usually Always

2. **This cat is timid:**

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree

3. **This cat is vocal around people :**

Never Once Occasionally Usually Always

4. **This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it:**

Never Once Occasionally Usually Always

(Where relevant) Please explain what happens/happened:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

5. **This cat <u>likes</u> being stroked:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

6. **I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws):**

Never	Once	Occasionally	Usually	Always

7. **When I am around this cat, it seems angry :**

Never	Once	Occasionally	Usually	Always

Please explain what has made you think this:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

8. **This cat has changed in the way it interacts with me since I first started working with it (e.g. has become <u>less</u> fearful, has become <u>more</u> fearful, behaves <u>more</u> aggressively, behaves <u>less</u> aggressively, is <u>less</u> friendly, is <u>more</u> friendly):**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Please expand on your answer:

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

9. **This cat is friendly:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

10. **The temperament and behavioural style of this cat will make it is easy to rehome:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Please expand on your answer:...

………………………………………………………………………………………………

………………………………………………………………………………………………

……………………………………………………………………………………………..

………………………………………………………………………………………………

Rehoming centre cat assessment process:

Table 8.9 Provisional cat profiles and their suggested management. Table of suggested *in-situ* environmental and behavioural management outcomes for each of the provisional profiles identified (Profiles (i-vi)), based on a combination of high and/or low L-CAT cluster scores (sSQ, sRQ and sFQ). In addition, intervention priority, 'owner matching' and potential suitable future physical and social environments for each profile are outlined.

L-cat cluster results	***Profile (i) Sociable cats low in fear and frustration reactivity:***	***Profile (ii) Sociable cats high in frustration reactivity:***	***Profile (iii) Sociable cats high in fear:***	***Profile (iv) Unsociable cats high in fear:***	***Profile (v) Unsociable cats high in frustration reactivity:***	***Profile (vi) Unsociable cats low in fear and frustration reactivity***
sSQ (social SEEKING) score	**H**	**H**	**H**	**L**	**L**	**L**
sRQ (social RAGE) score	**L**	**H**			**H**	**L**
sFQ FEAR (social FEAR) score	**L**		**H**	**H**		**L**
Rehoming Centre Management:	Cat may benefit from regular human interactions and handling.	Cat may benefit from (controlled) regular human interactions. Environmental and behavioural interventions to help manage frustration (i.e. provision of positively stimulating	Environmental and behavioural interventions to help manage fear/anxiety (i.e. pheromone therapy, provision of additional hiding areas, predictable routines and	Minimal human handling and interaction. Environmental management to reduce fear/anxiety (i.e. pheromone therapy, minimal disturbance and	Minimal human handling and interaction to reduce risk of injury and detrimental effects to cats' welfare. Behavioural modification/interventions may not be	Minimal human handling and interaction. Behavioural modification/interventions may not be suitable

		resources, education of handlers to avoid exceeding cats' interaction threshold).	handling, desensitisation and counter-conditioning to human presence)	provision of additional hiding areas, predictable routines). Behavioural modification/interventions may not be suitable	suitable	
	Normal environmental management	General environmental stress management	General environmental stress management	General environmental stress management	General environmental stress management	General environmental stress management
'Intervention' priority:	Low: Least priority for specific environmental and/or behavioural interventions	Medium : Environmental and behavioural management may be required to avoid compromised welfare	Medium : Environmental and behavioural management may be required to avoid compromised welfare	High : Prolonged exposure to a rehoming environment may be detrimental to welfare	High : Prolonged exposure to a rehoming environment may be detrimental to welfare	High : Prolonged exposure to a rehoming environment may be detrimental to welfare
Owner matching:	Less stringent owner-matching may be required	More careful matching of cat to owner may be required. May require management of owner expectations	More careful matching of cat to owner may be required. May require management of owner expectations	N/A	N/A	N/A

(potential) Future Placement: ***(Physical environment)***	May be most suitable to reside in a domestic environment in the close proximity of people	May be suitable to reside in a domestic environment in the close proximity of people but will require more careful management (i.e. provision of stimulating resources)	May be suitable to reside in a domestic environment in the close proximity of people but will require more careful management (i.e. quiet, predictable lifestyle with abundance of hiding places)	May not be suitable to reside in a domestic environment in the close proximity of people, but possibly other environments such as farm/out buildings etc.	May not be suitable to reside in a domestic environment in the close proximity of people, but possibly other environments such as farm/out buildings etc.	May not be suitable to reside in a domestic environment in the close proximity of people, but possibly other environments such as farm/out buildings etc.
(potential) Future Placement: ***(Social environment)***	May be suitable as a social companion for humans. May be most suitable cat for potential owners scoring high for sSQ(o) on owner ideal questionnaire	May be suitable as a social companion for humans but require more careful or restricted human interactions (i.e. minimal physical contact and/or close observation to tolerance threshold during interactions)	May be suitable as a social companion for humans but require more careful or restricted interactions with humans (i.e. especially with unfamiliar people). May not be suitable for potential owners scoring low for sFQ(o) on owner ideal questionnaire	May not be suitable as a social companion for humans	May not be suitable as a social companion for humans	May not be suitable as a social companion for humans

Table 8.10 L-CAT (c) scoring system: Five of the six (refined) L-CAT items (those that were reliable from the rehoming centre to the home and were also associated with increased owner satisfaction) taken from the L-CAT Questionnaire, Figure 8.2) are used to create composite item scores for the purposes of cat-owner matching. Answers for each item on the L-CAT questionnaire (staff assessments of the cat) are scored from the left to right-hand side of the page (1= far left, 5-far right). sSQ(c) and sFQ(c) cluster scores are then calculated by adding items together (q5+q9 for sSQ(c) and q1+q2+q4 for sFQ(c)). Items that need reversing prior to calculating cluster scores are indicated with an (R) beside them. Boxes are provided to impute the total cluster scores and select whether the score is 'High', 'Medium' and 'Low' based on the ranges indicated.

Score answers from left to right 1=far left 5= far right. Reverse the scores for items with an (R) next to them.	Question Score:		
1. This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:			
2. This cat is timid:	(R)	**sSQ(c)** Score: (5+9)	**sFQ(c)** Score: (1+2+4)
4. This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it :		/10	/15
5. This cat likes being stroked :	(R)	❑ High ❑ Med ❑ Low	❑ High ❑ Med ❑ Low
9. This cat is friendly :	(R)		

Table 8.11 L-CAT (o) scoring system: Five of the six (refined) L-CAT items (those that were reliable from the rehoming centre to the home and were also associated with increased owner satisfaction), taken from the owner ‘ideal’ version of the L-CAT Questionnaire (the L-CAT (o) questionnaire, Figure 8.3) are used to create composite item scores for the purposes of cat-owner matching. Answers for each item on the L-CAT(o) questionnaire are scored from the left to right-hand side of the page (1= far left, 5-far right). sSQ(o) and sFQ(o) cluster scores are then calculated by adding items together (q5+q9 for sSQ(o) and q1+q2+q4 for sFQ(o)). Boxes are provided to impute the total cluster scores and select whether the score is ‘High’, ‘Medium’ and ‘Low’ based on the ranges indicated.

Score answers from left to right : 1=far left 5= far right.	Question Score:		
1. I’d like a cat that won’t try to avoid me when I go to stroke it or tickle its chin/cheeks:			
2. It’s important the cat isn’t timid:		**sSQ(c)** Score: (5+9)	**sFQ(c)** Score: (1+2+4)
4. I don’t want a cat that behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it:		/10	/15
5. I don’t want a cat that likes being stroked:		❑ High ❑ Med ❑ Low	❑ High ❑ Med ❑ Low
9. It’s not important to me that the cat is friendly:			

Figure 8.3 L-CAT(o) Questionnaire: The owner version of the L-CAT(c) containing items found to be reliable *between* the rehoming environment and the home. Items are worded to ascertain prospective owners 'ideal' ratings for each behavioural item. To be filled out by prospective cat-adopters (prior to meeting or reserving specific cats) for the purpose of gauging owner 'ideals' that can then be matched with staff ratings of a cats' 'actual' (based on L-CAT(c)) behaviour to facilitate suitable cat-owner matching.

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Your ideal cat

Instructions:

Based on the IDEAL characteristics you would like a cat to have, please indicate how much you agree or disagree with the following statements in relation to your IDEAL cat.

- Please answer this questionnaire as honestly as possible. There are no right or wrong answers - we are purely interested in your individual preferences and opinions.

- Please answer all questions by circling the response that is most appropriate.

Example question:

I want a cat I can groom everyday

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Questions:

I'd like a cat that won't try to avoid me when I go to stroke it or tickle its chin/cheeks:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

It's important the cat isn't timid:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

I don't want a cat that behaves aggressively (i.e. growls, hisses, bites, swipes with

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

I don't want a cat that <u>likes</u> being stroked

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

It's not important to me that the cat is friendly:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Table 8.12 A provisional Cat-owner matching guide, suitable for matching Profile (i-iii) cats with prospective adopters. Owner are assessed on relative sSQ(o) and sFQ(o) scores (i.e. whether high or low) in relation to which cats they may or may not be suitable to rehome (based on a cat's sSQ(c) and sFQ(c) scores)

Owner ideals:	**High score:**	**High score:**	**Low score:**	**Low score:**
sSQ(o) (social SEEKING)	**x**		**x**	
sFQ(o) (social FEAR)		**X**		**x**
Owner matching implications	Owners may be more suited to cats with higher sSQ (c)scores	Owners may be more suited to cats with higher sFQ(c) scores, but potentially also a range of sFQ(c) scores	Owners may be more suited to cats with a range of sSQ(c) scores	Owners may not be suitable for cats scoring high for sFQ(c

8.5 Future work:

Building on from the work presented within this thesis, the following individual work components are suggested:

8.5.1 Assessing the utility and effectiveness of the proposed Lincoln Rehoming centre Cat Assessment Process (L-RCAT):

A next important step regarding the proposed method of cat assessment is to determine the practicality, ease of use and (where possible) effectiveness of each element of the assessment process, as well as the L-RCAT as a whole.

The practicality and ‘user friendliness’ of the L-CAT questionnaires and L-CAT, L-CAT(c) and L-CAT(o) profiling by rehoming centre staff should be determined, in order to assess any potential limitations of the proposed models. Additionally, the ease of implementation of the suggested behavioural and environmental management/interventions outlined within the framework should also be assessed. Trial periods at various centres followed by a series of L-RCAT user focus groups may be particularly useful in order to gain useful feedback from staff.

Future work should also assess the types of profiles most frequently identified across various locations and large populations, to ensure that suggested interventions are targeted to represent the most relevant of cat profile combinations (if different from the provisional ones presented within this thesis - profiles (i-vi)). Such data could be collected via completed L-CAT questionnaire score sheets (see Table 9.8) from participating rehoming centres. Relative combinations of cluster scores can then be studied to assess the types of ‘profiles’ that occur most commonly.

Additionally, the effectiveness of the proposed management strategies should be assessed. Using a matched-groups design, groups of cats for each profile type (i.e. (i-vi)) could either receive the appropriate interventions as outlined in the L-RCAT, or receive the interventions usually performed within the rehoming centre. L-RCAT strategy effectiveness could then be evaluated based on the frequency of aggressive behaviour (e.g. frequency of incidents of human-directed aggression, its type and severity), time within the rehoming environment/time to adoption (Gourkow and Fraser 2006), as well as individual wellbeing (based on a combination of relevant measures; for example, cat stress scores (Kessler and Turner 1997,1999, Ottoway and Hawkins 2003, McCobb *et al* 2005), cortisol:createnine ratios (Carlstead *et al* 1993, McCobb *et al* 2005, Gourkow *et al* 2014), immunoglobulin A secretion (Gourkow *et al* 2014)), and other general sickness behaviours (Stella *et al* 2011, Tanaka *et al* 2012) etc.) between the two groups.

8.5.2 Assessing the utility and effectiveness of the proposed cat-owner matching process:

The practicality of use and potential compliance of prospective owners in relation to the filling out of L-CAT(o) questionnaires is also advised, as is the effectiveness of the suggested cat-owner matching process. Practicality and compliance could be assessed via rehoming/reception staff focus groups to gain useful feedback. Effectiveness of the outlined L-RCAT matching process could be evaluated by obtaining adopter 'satisfaction' scores (i.e. see Chapter 7) from owners post-adoption, as well as potentially cat return rates (if performed on a large enough population of rehomed cats), and then comparing these factors between groups of owners that either were or were not exposed to the matching (and where appropriate 'management of expectations') process.

Whether current in-situ L-CAT sRQ scores *could* be used as an effective cat-owner matching and 'preventative management' tool could be explored by using a matched-groups design, where the frequency of post adoption human-directed aggression (and again potentially also 'satisfaction scores') is compared between owners that have and have not been educated about/matched with suitable cats based on L-CAT sRQ scores.

8.5.3 Psychometric profiling of owners:

Because all bar one of the (refined) L-CAT items were associated with higher owner post-adoption satisfaction, but were not actually able to predict absolute satisfaction levels, it is possible that other features of the adopter (such as levels of pet attachment and personality) may additionally contribute towards owner satisfaction. In both dogs and cats, there is evidence to suggest that owner personality and pet attachment are intrinsically linked (Reevy and Delgado 2015), and such human characteristics may not only affect levels of adopter-satisfaction, but also the general health and wellbeing of the pet (see Serpell 1996, Adamelli *et al* 2005, Marinelli *et al* 2007, Curb *et al* 2013). Previous studies have suggested that owner satisfaction is greater when a pets' personality is perceived as complimentary to their own (Curb *et al* 2013) and also when they feel a stronger level of attachment towards their pet Serpell (1996). In relation to the wellbeing of the pet, levels of attachment towards owners were found to correlate positively with the strength of owner attachment towards the pet (Marilelli *et al* 2007), with the quality of life (QoL) of the pet also being greater when owners had more emotional bonds with other conspecifics (Adamelli *et al* 2005, Marinelli *et al* 2007).

If relevant aspects of owner variability could be reliably assessed/predicted in adopters prior to adoption, it is possible that such information could be used to enhance the proposed cat-owner matching process (i.e. L-CAT(o)) and thus the general effectiveness of the assessment tool (i.e. the L-RCAT) in relation to successful cat rehoming.

8.5.4 Potential methods to assess affect-based differences within gross behavioural outputs:

Limitations in the behavioural test measures in relation to their cross-environment/social context reliability as well as heterogeneous relationship with other types of measures were interpreted as being the result of variability in the affective quality of the gross behaviours that were measured (see Chapters 3 and 5). Further work (see below) is thus suggested to assess whether other types of qualitative methods of behavioural assessment could be used in conjunction with/ as a replacement for the current behavioural test measures (see Chapter 3), in order to better and more reliably identify and differentiate between affect-based differences in the behavioural outputs of cats during test scenarios. If this were possible, such methods could potentially improve the predictive validity of behavioural observations made in the rehoming centre in relation to future post-centre behaviour, as well as potentially helping to better predict adopter-satisfaction.

The following methods that could be used to determine affect-based qualities from gross behavioural outputs are briefly discussed.

8.5.4.1 Assessing the vocal parameters within the ‘meow’:

There is evidence to suggest that with both the purr and the meow, the duration and frequency of sound may vary depending upon the external context and associated valence (see Nicastro and

Owren 2003, McComb 2009, Yeon *et al* 2011, Schötz and van de Weijer 2014). Therefore the analysis of vocal parameters within the meow might be a useful tool in identifying different affective states or social functions within different test contexts and behavioural responses. However, the practicality of such analysis for use in the rehoming environment may be limited because specialist analytical software is required (e.g. PRATT acoustic sound analysis software (see Boersma and Weenink 2001)).

8.5.4.2 Facial behaviours and underpinning emotion:

Previous studies on the involuntary or spontaneous facial behaviours in humans have suggested the existence of specific movements that relate to different types of emotional activation or affect (Ekman and Friesen 1978). More recently, facial behaviour coding systems similar to those created by Ekman have been developed for use in non-human animals (for examples see ChimpFACS:Vicks *et al* 2007, dogFACS:Waller *et al* 2013 and catFACS: Caeiro *et al* 2013), providing a potentially reliable framework to describe different facial movements in relation to their biological underpinning. In primates, such systems have so far been used to identify combinations of movements that are specific to certain behavioural contexts, and are also differentiable by conspecifics (Parr *et al* 2007a). It is therefore possible that this framework could be used to identify facial movements that may also relate to different types of affect or emotional valence (Parr *et al* 2007b), and could thus provide an extra level of behavioural detail in the interpretation of gross behavioural outputs such as those measured in the current experiment.

8.5.4.3 Laterality:

Research in various species suggest that each hemisphere of the brain controls behavioural responses associated with different types of external stimuli (namely the left side being responsible for actions associated with non-stressful situations (e.g. Peirce *et al* 2000), and the right for unexpected stimuli and immediate self-preservation types of behaviour (e.g. Adamec *et al* 2005)), and that limb preference in various contexts may indicate different predispositions associated with different types of affect (See review by Rogers 2010). In domestic cats, there is some evidence of lateralization in limb use during functional behavioural tasks (Wells and Millsopp 2009) as well as in physiological responses during exposure to a stressor (Mazzotti and Boere 2009).

Assessing laterality in salient facial behaviours (such as those identified in the catFACS, see Caeiro *et al* 2013) and/or facial/body rubbing of people (that may also serve several different context-specific functions (e.g. see Feldman (1994), Bradshaw and Cameron-Beaumont (2000)) could potentially provide an additional source of detailed behavioural information which might then be applied to present measures in order to identify function and/or affect-based differences within a behaviour or context.

8.5.5 Improving the predictive validity of current measures in relation to RAGE, post adoption.

Because both the final behavioural test model as well as the L-CAT questionnaire model were unable to reliably predict RAGE-based behavioural tendencies in individuals post-adoption, it is suggested that the types of qualitative behavioural measures described above could be specifically targeted to this core emotional process, and its differentiation from other affective states, with the aim being to facilitate a more reliable level of identification of RAGE activation during tests.

Because poor predictability in relation to frustration reactivity (RAGE) (from rehoming centre to home) could also be the result of a limited ability of owners to recognise social frustration in their newly adopted cat, it is suggested that further work should explore whether improved owner education could be used to help improve the reliable identification of RAGE post-adoption. To test this hypothesis, the predictive validity of staff-rated sRQ scores in relation to owner-rated sRQ scores could be compared between matched groups of owners that did and did not receive training in recognising socially-mediated frustration in cats.

Finally, assessing the predictive validity of Handling Issues (HI) in relation to post-adoption behaviour is also recommended. This could be determined by gathering HI data on all cats prior to adoption and assessing whether HI can reliably predict owner-rated sRQ scores post-adoption.

8.6 Overall conclusions:

This research has resulted in the provision of a first-of-its-kind tool that can generate practical, non-invasive and valid information about the behavioural tendencies of cats in relation to aspects of human-sociability, not only within the rehoming environment, but also in a predictive capacity in relation to future post adoption behaviour within the home, as well as to aspects of owner-satisfaction.

In its application, this tool has the potential to have a substantial impact upon the welfare of cats housed within rehoming environments. The L-RCAT tools can be used to quickly assess cats for their suitability for homing as a pet cat, optimally manage them within the rehoming centre, and match them with prospective owners where appropriate. This approach allows the individual social needs of both cat and adopter to be considered, ensuring they are well suited to each other. More optimal cat-owner matching may potentially reduce the likelihood of future relinquishment, as well as increasing the cat's quality of life post-rehoming.

Many of the behavioural responses of cats measured were found to be very inconsistent across various social, environmental and temporal gradients, and such results would suggest that the functions and emotional context associated with certain behaviours may vary, but could also suggest a large amount of behavioural flexibility within general population of cats within the rehoming centre.

This research sheds important light on the difficulties associated with being able to reliably and practically assess the temperament of cats within the rehoming environment, and provides insight into the general limitations associated with the types of methods that are commonly used in various temperament tests that have been developed for the domestic cat (i.e. particularly those based on basic quantitative measures of observed behaviour, e.g. see Reisner *et al* 1994, Bradshaw and Cook 1996, Low and Bradshaw 2000, Slater *et al* 2013a&c). It challenges the utility of such tests where sufficient reliability and validity of measures have not been demonstrated, and also provides evidence in favour of utilising and exploring more qualitative approaches that may be better able to reliably assess aspects of a cat's temperament within the rehoming environment.

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Appendices:

Chapter 2:

Appendix: 2.1. Individual scores for each cat for each behavioural measure in Cluster 1.

Cat Identity	Cluster 1: Individual scores for each test measure				
	em_voc_tot_u_p	em_voc_tot_u_a	em_voc_tot_f_p	em_voc_tot_f_a	Cluster 1 score
allsorts	0	0	0	1	1
angelis	0	0	0	0	0
ant	0	0	0	0	0
becky	0	0	0	2	2
beethoven	0	0	0	0	0
bramble	0	5	0	2	7
bruno	0	0	0	0	0
bubba	0	0	0	0	0
gc	2	3	3	7	15
millie	0	0	2	0	2
monty	5	3	1	0	9
nelly	4	0	0	0	4
poppy(w3)	4	4	1	1	10
poppy(w4)	25	19	19	18	81
raymond	3	0	1	0	4
rosie	9	9	11	5	34

Appendix: 2.2. Individual scores for each cat for each behavioural measure in Cluster 2.

Cat Identity	**Cluster 2: Individual scores for each test measure**			
	em_app_tot_u_p	em_rub_tot_u_p	em_rub_tot_f_p	Cluster 2 score
allsorts	0	0	0	0
angelis	1	0	2	3
ant	1	0	0	1
becky	1	4	2	7
beethoven	0	0	0	0
bramble	5	4	1	10
bruno	1	1	0	2
bubba	1	0	0	1
gc	0	0	0	0
millie	0	0	0	0
monty	0	0	0	0
nelly	1	0	0	1
poppy(w3)	0	0	0	0
poppy(w4)	0	0	0	0
raymond	0	0	0	0
rosie	0	0	0	0

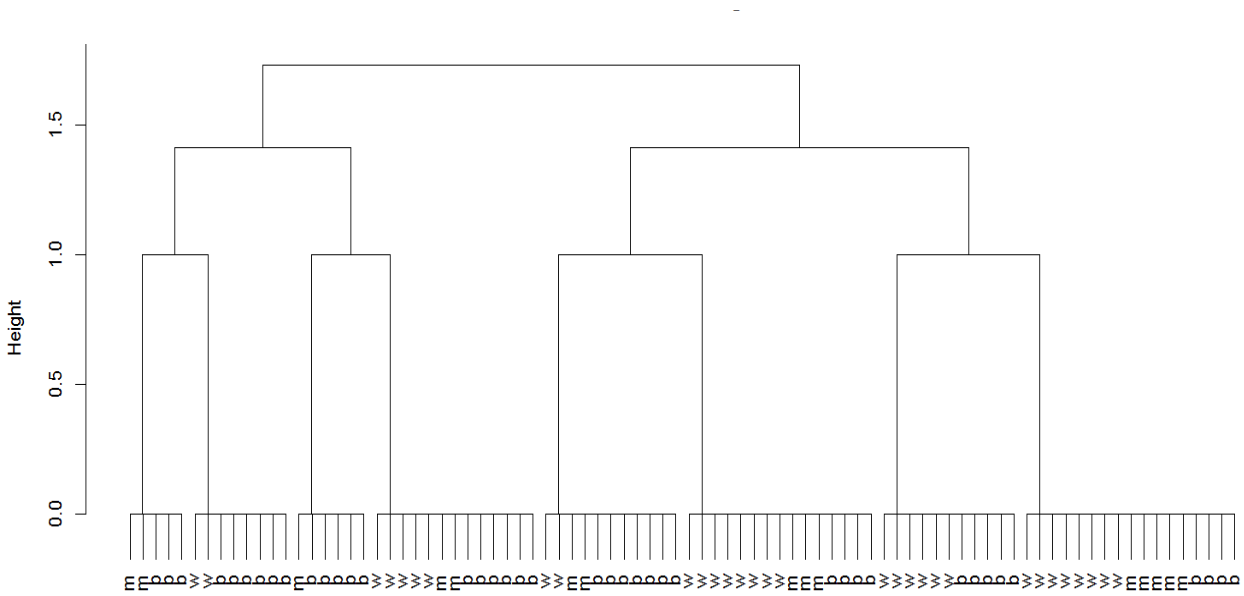
Appendix: 2.3 Individual scores for each cat for each behavioural measure in Cluster 3.

Cat Identity	**Cluster 3: Individual scores for each test measure**									
	i_walks_away_pers_u	i_walks_away_pers_f	am_f_walks_away_pers_tot_f	em_app_tot_f_p	em_app_tot_u_a	i_rub_tot_f	i_rub_tot_u	i_sniff_tot_u	i_looks_away_pers_u	Cluster 3 score
allsorts	8	4	1	0	8	18	31	6	4	80
angelis	8	10	9	3	1	2	6	2	6	47
ant	0	0	2	3	2	0	0	0	3	10
becky	5	3	3	2	3	3	11	7	5	42
beethoven	7	0	3	4	6	1	31	0	2	54
bramble	1	0	3	1	4	0	1	1	11	22
bruno	3	5	3	1	7	27	32	6	5	89
bubba	4	3	0	2	1	1	4	7	1	23
gc	0	0	0	0	0	0	0	0	0	0
millie	0	2	2	1	3	2	0	1	7	18
monty	0	0	0	0	4	0	0	0	0	4
nelly	1	0	0	1	3	23	7	0	10	45
poppy(w3)	0	0	0	0	0	0	0	0	0	0
poppy(w4)	0	0	1	0	0	0	0	0	0	1
raymond	6	1	2	1	1	28	26	5	7	77
rosie	5	7	1	1	1	5	8	3	1	32

Appendix: 2.4. Individual scores for each cat for each behavioural measure in Cluster 4.

Cat Identity	Cluster 4: Individual scores for each test measure										
	em_app_tot_f_a	em_rub_tot_u_a	em_rub_tot_f_a	am_f_looks_away_pers_tot_u	am_f_looks_away_food_tot_u	am_f_looks_food_tot_u	am_f_looks_food_tot_f	am_f_looks_away_food_tot_f	i_freq_look_toy_u	am_f_freq_food_sniff_f	Cluster 4 score
allsorts	10	28	16	7	0	3	6	4	3	0	77
angelis	0	1	0	7	4	6	12	4	3	1	38
ant	4	0	3	17	5	9	8	4	5	0	55
becky	2	2	4	7	2	4	6	3	3	1	34
beethoven	0	8	0	10	5	8	6	3	3	0	43
bramble	5	8	20	7	4	6	6	5	3	1	65
bruno	4	24	13	7	2	2	6	5	5	0	68
bubba	0	0	0	7	2	7	0	0	4	0	20
gc	0	0	0	0	0	0	0	0	0	0	0
millie	1	0	0	10	2	6	6	3	3	1	32
monty	10	2	4	0	0	0	2	1	0	0	19
nelly	1	21	24	10	3	6	11	7	3	4	90
poppy(w3)	0	0	8	0	0	0	0	0	0	0	8
poppy(w4)	2	0	1	12	5	6	0	0	4	0	30
raymond	2	6	7	4	5	9	12	11	3	2	61
rosie	1	0	0	1	0	0	5	4	1	0	12

Chapter 3:



Appendix: 3.1 ‘Cat location’ Dendrogram of the Hierarchical Cluster Analysis (HCA) performed on the reliable measures from Experiment 2 (see Table 3.4). Dendrogram of individual cat by location (n=101, 48 from BDCH, 35 from WG and 18 from MHW) produced using average linkage between groups based on binary squared Euclidean distance matrix. Dendrogram key: b=BDCH, m=MHW, w=WG.

Chapter 4:

Appendix 4.1 Initial Questionnaire (Q.A1) filled in by staff having worked with a specific test cat for a minimum of 1 week prior to questionnaire completion

FOR OFFICE USE ONLY
Adoption Centre:
Cat name:
I.D number:

UNIVERSITY OF LINCOLN

Questionnaire Q.A1

(staff version)

Respondent Name/ID ref:

Instructions to rehoming staff:

This questionnaire is part of an on-going research project conducted by the University of Lincoln and sponsored by International Cat Care and the Centre Of Applied Pet Ethology (COAPE). Its aims are to improve the welfare of cats in rehoming facilities, by helping to better assess their temperaments.

Your participation in this study is greatly appreciated!!

- This questionnaire is designed to assess aspects of the behaviour of cats, particularly in their response towards humans. There are no right or wrong answers - we are purely interested in your impressions and opinions.

- Your responses to the questionnaire are confidential and will not be read by other members of staff. They will only be viewed by researchers at the University of Lincoln for the purposes of assessing people’s perceptions of cat’s behaviour and temperament. Any answers given here will not be passed on to any other parties.

<u>Please hand this questionnaire directly back to Lauren Finka upon completion. If you wish to seal your questionnaire in an envelope before returning, one will be provided.</u>

Please enter the following details about the cat:

1. Name:……………………………………………….

2. I.D number:……………………………………………..

3. Age:…………………………………………….

4. Colour: ………………………………………………..

5. Breed (please tick): **DSH:** ☐ **DSLH:** ☐ **DLH:** ☐

   Pedigree: ☐ (Please specify which breed)
   …………………………………………………………………………

6. Sex**: Male / Female**

7. Neuter status: **Neutered / Unneutered / Unknown** ?

8. Date of arrival to shelter: __ __ /__ __ /__ __

9. Medical/health issues known about:……………………………………………………………………………………
   ……………………………………………………………………………………………

…………………………………………………………………………………………
…………………………………………………………………………………………

10. Any behavioural issues identified (either by you or any other members of staff)?.............................
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………

Please enter a few details about yourself below:

1. Your age:…………………………………………

2. Are you Male or Female?...

3. Roughly how long have you worked with cats in adoption/rehoming centres for? (this can be the total combined time from several different centres)

…………..Months …………. Years

4. Roughly how long in total have you worked with this specific cat for?

………… Days …………. Weeks ………… Months

<u>Instructions:</u>

- Depending upon the specific question, please indicate either how much or little you agree with a particular statement, or how often the situation described has occurred. Please answer all questions by circling the response that is most appropriate, and circle ONLY ONE response per question If you are unsure of an answer to a question, please circle the 'Unsure' option.

E.g.: Q1. This cat likes being groomed:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

- Please do not fill in this questionnaire at a time when you are directly interacting with the cat. If any of the following questions describes a situation you have not yet experienced with the cat (i.e. picking them up), please select the 'Unsure' option, rather than trying to pick them up now in order to answer the question.
- Where dotted lines are provided because a written explanation is required, please make sure none of those beginning with ** are left blank.

Questions:

1. **1. This cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.):**

Never	Once	Occasionally	Usually	Always

Or, Unsure

2. **This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

3. **This cat is comfortable being picked up:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

4. **When I try to initiate contact or interaction with the cat, it doesn't move away but is quiet and not very responsive towards me (i.e. it doesn't purr or rub against me):**

Never	Once	Occasionally	Usually	Always

Or, Unsure

5. **This cat is timid:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

6. **This cat will approach me when I enter its unit/pen to say 'hello' (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

7. **This cat is vocal around people :**

Never Once Occasionally Usually Always

Or, Unsure

8. **This cat will <u>actively approach</u> me in order to ask for attention and to initiate contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles):**

Never Once Occasionally Usually Always

Or, Unsure

9. **This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it:**

Never Once Occasionally Usually Always

Or, Unsure

(Where relevant) Please explain what happens/happened:

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

10. **This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I performed routine health procedures (such as grooming/ carrying out health checks or when administering medication, etc.):**

Never Once Occasionally Usually Always

Or, Unsure

11. **This cat is keen to explore new things in its environment:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

12. **This cat takes a long time to settle and to adapt to change in its environment:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

13. **This cat is playful**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

14. **This cat has got carried away during play, which has led to me being bitten or swiped at:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

(Where relevant) please explain what happened:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

15. **If this cat could choose, it would prefer to be left alone, rather than be with people:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

16. **This cat <u>likes</u> being stroked:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

17. **I have avoided stroking or handling this cat because I feel that it doesn't want me to:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

18. **This cat is very <u>tolerant</u> of being handled:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

19. **I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws):**

Never Once Occasionally Usually Always

Or, Unsure

20. **When I am around this cat, it seems angry:**

Never Once Occasionally Usually Always

Or, Unsure

****Please explain what has made you think this:**

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………………………….

21. **If this cat could choose, it would prefer to have a bowl of food rather than interact with me:**

Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree

Or, Unsure

22. **This cat is more keen to interact with me and be near me when I have food /treats:**

Never	Once	Occasionally	Usually	Always

Or, Unsure

23. **This cat has changed in the way it interacts with me since I first started working with it (e.g. has become <u>less</u> fearful, has become <u>more</u> fearful, behaves <u>more</u> aggressively, behaves <u>less</u> aggressively, is <u>less</u> friendly, is <u>more</u> friendly):**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

24. **This cat behaves differently with strangers than it does with me :**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

25. **This cat behaves differently with other members of staff than it does with me :**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

26. **This cat is friendly:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

27. **This cat is fearful:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

28. **The temperament and behavioural style of this cat will make it is easy to rehome:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

****Please expand on your answer:**
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

Finished!

Thank-you☐ !!

If you would like to be entered in to a draw to win a years' free membership to International Cat Care, please tick this box: ☐

If you ticked the box, please provide your email address or other means of contact below:
…………………………………………………………………………………………
………………………

<u>Please hand this questionnaire directly back to Lauren Finka upon completion. If you wish to seal your questionnaire in an envelope before returning, one will be provided.</u>

Appendix 4.2 Refined version of QA.1 (staff version), now referred to as the Lincoln Cat Assessment Test (L-CAT).

UNIVERSITY OF LINCOLN

Lincoln Cat Assessment Test (L-CAT)

Instructions to rehoming staff:

Please enter the Cats details below:

11. Name:……………………………………………….

12. I.D number:……………………………………………..

13. Age:…………………………………………….

14. Colour: ……………………………………………..

15. Breed (please tick): **DSH:** ☐ **DSLH:** ☐ **DLH:** ☐

Pedigree: ☐ (Please specify which breed)

…………………………………………………………………………

16. Sex**: Male / Female**

17. Neuter status: **Neutered / Unneutered / Unknown** ?

18. Date of arrival to shelter: __ __ /__ __ /__ __

19. Medical/health issues known about:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

20. Any behavioural issues identified (either by you or any other members of staff)?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Questionnaire instructions:

- Depending upon the specific question, please indicate either how much or little you agree with a particular statement, or how often the situation described has occurred. Please answer all questions by circling the response that is most appropriate, and circle ONLY ONE response per question.

E.g.: Q1. This cat likes being groomed:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

- Please do not fill in this questionnaire at a time when you are directly interacting with the cat.

Questions:

1. **This cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:**

Never	Once	Occasionally	Usually	Always

2. **This cat is timid:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

3. **This cat is vocal around people :**

Never	Once	Occasionally	Usually	Always

4. **This cat has behaved aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I have stroked it:**

Never	Once	Occasionally	Usually	Always

(Where relevant) Please explain what happens/happened:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

5. **This cat likes being stroked:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

6. **I have avoided stroking this cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws):**

Never	Once	Occasionally	Usually	Always

7. **When I am around this cat, it seems angry:**

Never	Once	Occasionally	Usually	Always

Please explain what has made you think this:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

8. **This cat has changed in the way it interacts with me since I first started working with it (e.g. has become less fearful, has become more fearful, behaves more aggressively, behaves less aggressively, is less friendly, is more friendly):**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Please expand on your answer:

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

9. **This cat is friendly:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

10. **The temperament and behavioural style of this cat will make it is easy to rehome:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Please expand on your answer:

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

Chapter 5:

Appendix 5.1 List of all individuals with complete Behaviour and Questionnaire cluster scores (n=88). Scores based on the groups identified in the HCA dendrograms (performed on the reliable behavioural test measures and QA.1 Questionnaire rehoming centre data).

	Cat	Behaviour Cluster 1 - sRB (Social RAGE)	Behaviour Cluster 3 - s/pSB (social and/or physical SEEKING)	Questionnaire item Cluster A (social SEEKING)	Questionnaire item Cluster B (social RAGE)	Questionnaire item Cluster C (social FEAR)
bdch	Abbey	0	1	19	3	4
mhw	Agnes	1	0	13	3	14
bdch	Alexa	22	1	17	3	5
bdch	Andre	3	6	13	7	10
wg	Angel	25	11	13	5	5
wg	Baileys	11	8	15	9	7
bdch	Barney	0	5	15	3	10
bdch	Basil	1	5	13	3	8
bdch	benj	3	3	17	3	3
bdch	Bibble	0	1	13	3	4
wg	Billybob	1	4	17	3	5
bdch	Bloo	0	1	15	3	8
bdch	Bloom	0	2	12	7	7
wg	Bobby	16	4	14	3	10
wg	Brian	58	5	15	3	6
bdch	bruce	0	0	14	3	8
wg	Bugsy	5	0	16	3	8
wg	Butter	29	3	15	3	8
bdch	Cafrey	0	1	17	3	5
bdch	caspian	0	3	12	3	11
wg	Charlie	0	4	13	3	7
bdch	Cheese	0	2	19	3	3
mhw	chelsea	8	11	18	3	5
bdch	Cher	2	0	13	3	9

mhw	Chica	67	0	19	6	10
mhw	Chris	14	0	16	3	10
mhw	cooper	96	0	12	3	12
bdch	cream	27	6	20	3	4
mhw	daenerys	0	0	13	6	9
mhw	danielle	6	4	13	3	9
wg	Dillion	0	0	14	3	6
mhw	Dolly	4	2	17	3	7
wg	Fenton	2	7	13	3	12
wg	Fifi	11	1	13	3	11
bdch	Finlay	0	0	12	9	11
wg	Flopsy	52	0	17	5	6
wg	Gizmo	12	5	15	3	7
mhw	Glenda	0	0	16	3	10
bdch	Gracie	0	0	11	3	9
bdch	Hollie	1	0	11	5	12
wg	Holly	47	0	19	3	7
bdch	Jazz	1	2	18	3	5
wg	Jazz	1	0	16	3	8
mhw	Jessy	1	0	13	3	9
wg	Jonesy	41	1	15	3	7
mhw	kayleigh	0	2	17	3	10
wg	Kitkat	3	5	15	3	5
wg	kitty	18	0	13	3	7
mhw	Louise	2	0	13	3	11
bdch	Lucky	13	0	14	3	9
wg	Lulu	0	0	15	3	7
bdch	madge	0	0	13	3	7
bdch	Maggi	39	1	13	3	5
wg	Maisy	75	0	13	3	10
bdch	Megan	0	4	18	3	5
mhw	mia	0	1	17	3	8
wg	Miele	0	0	13	3	7
wg	Millie	0	5	14	5	7
bdch	Miss Baby	2	2	14	3	11
wg	Misty	0	4	9	11	10
wg	Molly	1	0	15	3	6
bdch	Olive	0	1	13	4	9
bdch	Olivia	0	1	17	3	4
bdch	Ollie	1	4	12	7	11
bdch	Patch	4	1	18	3	6
bdch	Patches	0	1	16	3	9

bdch	Paulie	1	1	13	3	9
wg	Persaya	1	1	13	3	11
wg	Pinkie	57	1	13	3	11
bdch	Poppy	5	1	14	3	8
mhw	princess	8	5	13	8	7
wg	Rio	150	9	12	3	6
wg	Rogan	0	0	15	3	10
bdch	Roger	0	0	13	7	7
bdch	Sandy	0	2	13	7	7
wg	Shadow	13	3	14	3	6
bdch	Shi	0	3	14	3	5
bdch	Smudge	5	1	13	3	9
bdch	Sonny	0	0	13	3	12
mhw	Stoney	0	1	15	7	6
wg	Susie	58	2	12	3	10
wg	thomasina	0	0	16	3	7
wg	Tilly	1	0	11	9	9
bdch	tootsie	0	0	16	3	7
bdch	Twizzle	18	2	13	3	7
mhw	wakeman	12	5	14	3	8
bdch	Zebedee	2	5	17	3	6
bdch	Zoosman	4	1	14	7	9

Chapter 6:

Appendix 6.1. Initial Questionnaire Q.A3 (owner) to be filled in by cat owners post adoption

Adoption Centre:
Cat adopted:
I.D ref:

UNIVERSITY OF LINCOLN

<u>Questionnaire Q.A3</u>

Thank-you very much for agreeing to be part of this on-going study. Your participation is greatly appreciated!!

<u>This questionnaire is intended to be filled in by the person it was addressed to. It is important that it is only filled in by this person.</u>

Even if you no longer have your adopted cat, we would still very much like you to fill in this questionnaire and send back to us.

Please answer this questionnaire as honestly as possible. This questionnaire is confidential and will not be read by any member of staff at the centre where you adopted your cat, only by researchers at the University of Lincoln.

<u>Questions:</u>

- Please answer the following questions, based upon the impression you currently have (or had, if your cat is no longer living with you) of your cat. Please do not fill in this questionnaire at a time when you are directly interacting with your cat.

- Depending upon the specific question, please indicate either how much or little you agree with a particular statement, or how often the behaviour described has occurred.
- Please answer all questions by circling the response that is most appropriate, if you are unsure of an answer please circle the 'Unsure' option.
- If any of the following questions describes a situation you have not yet experienced with your cat (i.e. picking them up) please select the 'Unsure' option, rather than trying to pick them up now in order to answer the question.
- Finally, there are no right or wrong answers - we are purely interested in your impressions and opinions.

E.g.: Q1. My cat likes being groomed:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

1. **My cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.):**

Never Once Occasionally Usually
Always

Or, Unsure

2. **My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks:**

Never	Once	Occasionally	Usually	

Always

Or, Unsure

3. **My cat is comfortable being picked up:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

4. **When I initiate contact or interaction with my cat, it doesn't move away but it is quiet and not very responsive towards me (i.e. it doesn't purr or rub up against me):**

Never	Once	Occasionally	Usually	

Always

Or, Unsure

5. **My cat is timid:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

6. **My cat will come and say ‘hello’ and approach me (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss:**

Never Once Occasionally Usually
Always

Or, Unsure

7. **My cat is vocal when around people:**

Never Once Occasionally Usually
Always

Or, Unsure

8. **My cat comes and asks me for attention and initiates contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles):**

Never Once Occasionally Usually
Always

Or, Unsure

9. **My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it:**

Never Once Occasionally Usually Always

Or, Unsure

(Where relevant) Please explain what happens/happened:……………………………………………………………..
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………………

10. **My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I perform routine health procedures (such as grooming/ carrying out health checks, or when administering medication, etc.):**

Never Once Occasionally Usually Always

Or, Unsure

11. **My cat is keen to explore new things in its environment:**

Never Once Occasionally Usually Always

Or, Unsure

12. **My cat is quick to settle and to adapt to change:**

Or, Unsure agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

13. **My cat is playful:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

14. **My cat gets carried away during play, which has led to me being bitten or swiped at:**

Never Once Occasionally Usually
Always

Or, Unsure

(Where relevant) Please explain what happens/happened:
…………………………………………………………….
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………

15. **My cat would prefer be left alone, rather than be with people:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

16. My cat <u>likes</u> being stroked:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

17. I avoid stroking or handling my cat because I feel that it doesn't want me to:

Never Once Occasionally Usually Always

Or, Unsure

18. My cat is very <u>tolerant</u> to being handled:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

19. I avoid stroking my cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws):

Never Once Occasionally Usually Always

Or, Unsure

20. My cat seems angry around me:

Never Once Occasionally Usually Always

Or, Unsure

Please explain what makes you think this:

………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………………………

21. If my cat could choose, it would prefer to have a bowl of food rather than interact with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

22. My cat is more keen to interact with and be near me when I have food/ treats:

Never	Once	Occasionally	Usually	Always

Or, Unsure

23. **My cat has changed in the way it interacts with me since I first adopted it (e.g. has become <u>less</u> fearful, has become <u>more</u> fearful, behaves <u>more</u> aggressively, behaves <u>less</u> aggressively, is <u>less</u> friendly, is <u>more</u> friendly):**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Please expand on your answer:

…………………………………………………………………………………………………

……..……………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

24. **My cat behaves differently with strangers than it does with me:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

Please expand on your answer:……………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

25. **My cat behaves differently with me than it does with other (human) members of the household:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure Or, Not applicable

Please expand on your answer:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

26. **My cat is friendly:**

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

Please explain what makes you think this:

………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

27. My cat is fearful:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

Please explain what makes you think this:

………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………

28. This cat has met all my expectations:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

29. I am happy with my cat:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

30. I feel my cat is happy living with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

Please explain what makes you think this:

………………………………………………………………………………………………

……

……

……

31. I have considered rehoming this cat to someone else or returning this cat to the place of adoption:

Never Once Occasionally Usually
Always

Or, Unsure

This is because:

……

……

……

……

32. I have already had to rehome this cat to someone else/return this cat because:

………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………………………………………
………………………………………………………………………

33. Date of rehoming the cat to someone else/returning to adoption centre:

__ __ /__ __ /__ __

34. I no longer have my cat but this is for a reason different from the above. The cat was no longer living with me after:

__ __ /__ __ /__ _

Finished! Thank-you !!

35. Please enter today's date:

__ __ /__ __ /__ _

<u>Please kindly return the filled-in questionnaire in the pre-paid envelope and return as soon as possible.</u>

Please indicate whether you would like to receive a notification which provides a summary of the results of this research:

Yes: ☐

No: ☐

If you would like to get in touch about this research for any reason, please email Lauren at lfinka@lincoln.ac.uk.

Appendix 6.2. Questionnaire QA.3 (staff version), designed to be filled in by owners of cats post-adoption. Questionnaire items are mapped against specific behavioural traits, their hypothesised relationship with underpinning emotional processes (marked with an ‘X’) and whether they involve social elements (s) (i.e. in relation to the human in an interactive capacity), or physical elements (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

QuestionnaireA.3	**Sociability (social) SEEKING**	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social/physical) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability**	**Owner-preference/perception**
1. My cat tries to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)				**X(s)**		**X(s)**			
2. My cat tries to avoid me when I go to stroke it or tickle its chin/cheeks				**X(s)**		**X(s)**			
3. My cat is comfortable being picked up	**X(s)**	**X(s)**	**X(s)**						
4. When I initiate contact or interaction with my cat, it doesn’t move				**X(s)**					

away but it is quiet and not very responsive towards me (i.e. it doesn't purr or rub up against me)									
5. My cat is timid				**X(s,p)**					
6. My cat will come and say 'hello' and approach me (i.e. the cat will approach and make physical contact with me), but will then wander off or move away shortly afterwards rather than staying for a long fuss		**X(s)**				**X(s)**			
7. My cat is vocal when around people	**X(s)**					**X(s)**			
8. My cat comes and asks me for attention and initiates contact with me (e.g. the cat comes and sits on my knee, or rubs up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)	**X(s)**	**X(s)**	**X(s)**						
9. My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I stroke it				**X(s)**	**X(s)**	**X(s)**			
10. My cat behaves aggressively (i.e. growls, hisses, bites, swipes with claws) towards me when I perform routine health procedures (such as grooming/ carrying out health checks, or when administering medication, etc.)				**X(s)**	**X(s)**	**X(s)**			
11. My cat is keen to explore new things in its environment		**X(p)**					**X(p)**		
12. My cat is quick to settle and adapt to change		**X(p)**					**X(p)**		
13. My cat is playful	**X(s)**						**X(p)**		

14. My cat gets carried away during play, which has led to me being bitten or swiped at					**X(p)**	**X(p)**			
15. My cat would prefer be left alone, rather than be with people							**X(p)**		
16. My cat <u>likes</u> being stroked	**X(s)**	**X(s)**	**X(s)**						
17. I avoid stroking or handling my cat because I feel that it doesn't want me to				**X(s,p)**	**X(s)**	**X(s)**			
18. My cat is very <u>tolerant</u> to being handled	**X(s)**	**X(s)**	**X(s)**						
19. I avoid stroking my cat because I think it will behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws)				**X(s)**	**X(s)**	**X(s)**			
20. My cat seems angry around me						**X(s)**			
21. If my cat could choose, it would prefer to have a bowl of food rather than interact with me							**X(p)**		
22. My cat is more keen to interact with and be near me when I have food/ treats							**X(p)**		
23. My cat has changed in the way it interacts with me since I first adopted it (e.g. has become <u>less</u> fearful, has become <u>more</u> fearful, behaves <u>more</u> aggressively, behaves <u>less</u> aggressively, is <u>less</u> friendly, is <u>more</u> friendly)				**X(s)**	**X(s)**	**X(s)**		**X**	
24. My cat behaves differently with strangers than it does with me				**X(s)**				**X**	

25. My cat behaves differently with me than it does with other (human) members of the household				**X(s)**				**X**	
26. My cat is friendly	**X(s)**	**X(s)**	**X(s)**						
27. My cat is fearful				**X(s,p)**					
28. This cat has met all my expectations									**X**
29. I am happy with my cat									**X**
30. I feel my cat is happy living with me									**X**
31. I have considered rehoming this cat to someone else or returning this cat to the place of adoption									**X**
32. I have already had to rehome this cat to someone else/return this cat because									**X**

Appendix 6.3. List of all individuals (*n=37*) with complete factor scores for each factor extracted from the final FA performed on the cat adopter QA.3 questionnaire.

Centre	Cat	'Satisfaction' factor	SEEKING (social) And boldness (i.e. an absence of FEAR)	RAGE, (social)	FEAR(social/physical)	Handling tolerance – SEEKING (social), Boldness	SEEKING (physical)
		factor_1	factor_2	factor_3	factor_4	factor_5	factor_6
bdch	Barney	30	35	6	4	10	6
bdch	Bloo	30	34	6	9	8	6
bdch	caspian	26	23	10	8	6	5
bdch	Cheese	28	30	6	15	8	7
bdch	Gracie	30	33	6	7	7	2
bdch	Hollie	30	27	10	9	6	5
bdch	Jazz	30	34	7	4	10	6
bdch	Lucky	26	29	7	8	8	7
bdch	Maggi	27	31	6	6	5	7
bdch	Olive	28	32	8	5	8	8
bdch	Ollie	30	29	8	8	7	6
bdch	Patch	30	29	6	7	10	6
bdch	Patches	27	33	6	9	8	6
bdch	Paulie	29	34	6	6	10	9
bdch	Poppy	26	28	6	6	8	6
bdch	Sandy	30	29	9	5	7	5
bdch	Shi	27	35	6	5	9	4
bdch	Twizzle	29	33	6	5	9	8
mhw	Agnes	28	23	8	7	5	5

mhw	chelsea	26	33	8	5	8	6
mhw	Chica	28	34	7	15	5	7
mhw	glenda	28	24	10	8	6	7
mhw	mia	29	27	8	8	7	6
wg	Billybob	30	34	6	7	8	9
wg	Brian	29	29	6	14	8	5
wg	Charlie	30	35	7	4	8	8
wg	Dillion	29	24	8	16	6	5
wg	Fifi	30	35	6	6	6	10
wg	Flopsy	24	23	12	14	5	2
wg	Jazz	25	23	10	11	5	6
wg	Lulu	30	33	10	8	8	6
wg	Millie	27	30	14	10	6	7
wg	Molly	30	35	6	7	7	6
wg	Pinkie	28	23	8	12	5	4
wg	Shadow	30	33	9	9	9	5
wg	Susie	28	31	6	12	4	4
wg	thomasina	23	24	7	16	5	6

Appendix 6.4. Polychoric item correlation matrix for all items included in the final Factor Analysis of questionnaire QA.3 scores. Data taken form 22 individual items across a population of 244 individuals that had been adopted from one of the 4 centres data collection was carried out at (CP, BDCH, MHW, WG), and had had a QA.3 filled out by their new owner post adoption.

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q11	q12	q13	q14	q15
q1	1	------	------	------	------	------	------	------	------	------	------	------	------	------
q2	0.6929	1	------	------	------	------	------	------	------	------	------	------	------	------
q3	0.3659	0.2869	1	------	------	------	------	------	------	------	------	------	------	------
q4	0.56	0.5215	0.301	1	------	------	------	------	------	------	------	------	------	------
q5	-0.3534	-0.2872	-0.361	-0.2931	1	------	------	------	------	------	------	------	------	------
q6	0.1113	0.198	-0.03001	0.2218	0.1088	1	------	------	------	------	------	------	------	------
q7	0.267	0.1192	0.1137	0.1935	-0.2271	0.0455	1	------	------	------	------	------	------	------
q8	0.4091	0.3816	0.2608	0.3985	-0.3319	0.1373	0.2915	1	------	------	------	------	------	------
q9	-0.2076	-0.193	-0.1826	-0.1422	0.03711	-0.05554	-0.07048	-0.1318	1	------	------	------	------	------

q11	-0.2155	-0.1901	-0.1466	-0.1688	0.4418	0.1014	-0.177	-0.1955	0.1265	1	------	------	------	------
q12	-0.381	-0.3204	-0.2929	-0.3482	0.5993	0.004731	-0.2906	-0.3548	0.09559	0.525	1	------	------	------
q13	0.2522	0.2176	0.267	0.2748	-0.2839	-0.1253	0.08257	0.1381	-0.09033	-0.3546	-0.2534	1	------	------
q14	-0.0454	-0.1319	-0.003936	-0.04005	-0.07296	-0.1164	0.04837	0.001177	0.4059	-0.1115	-0.05123	0.1605	1	------
q15	0.4304	0.3591	0.2066	0.3185	-0.3721	0.06176	0.2462	0.4713	-0.0649	-0.2444	-0.3106	0.2499	0.04902	1
q16	0.369	0.4402	0.274	0.3688	-0.2234	0.1922	0.1688	0.4037	-0.3247	-0.1082	-0.2649	0.1514	-0.08599	0.3737
q17	-0.4341	-0.4859	-0.2999	-0.4456	0.1732	-0.1962	-0.1654	-0.2655	0.2543	0.0617	0.1421	-0.1553	0.134	-0.3787
q18	0.4385	0.3884	0.6201	0.3743	-0.4078	0.0838	0.1393	0.3999	-0.273	-0.2075	-0.43	0.2125	-0.1445	0.3583
q19	-0.3004	-0.2778	-0.213	-0.279	0.1034	-0.08498	-0.1008	-0.2068	0.5676	0.03191	0.1383	-0.06735	0.365	-0.2063
q20	-0.2642	-0.1885	-0.2052	-0.2386	0.1133	-0.0692	-0.07497	-0.03644	0.4522	0.161	0.2244	-0.06425	0.09806	-0.1578
q21	0.153	0.173	-0.05816	0.1632	-0.002833	0.1062	0.04258	0.1863	-0.03505	-0.1897	-0.1605	0.1622	-0.03411	0.2491
q22	0.09882	0.145	0.118	0.186	0.01227	0.03425	-0.01211	0.1149	-0.08748	-0.01135	-0.1103	0.1242	-0.05521	0.08841
q23	-0.15	-0.154	-0.208	-0.175	0.2296	-0.127	-0.1021	-0.1085	0.07028	0.1236	0.1642	-0.08791	-0.01011	0.005336

q25	-0.04226	-0.02621	-0.05683	-0.1228	0.09934	0.03436	-0.0225	0.07253	-0.000376	0.0155	-0.01328	-0.07633	0.06311	-0.04827
q26	0.4895	0.4009	0.3383	0.4073	-0.3418	0.1038	0.2452	0.3781	-0.3048	-0.369	-0.4243	0.3189	-0.06145	0.4303
q27	-0.3247	-0.2583	-0.2933	-0.1907	0.6238	0.06007	-0.1031	-0.2467	0.07463	0.3645	0.5413	-0.1905	-0.05572	-0.3576
q28	0.4009	0.3632	0.2596	0.331	-0.2517	0.0524	0.1609	0.3068	-0.2923	-0.3136	-0.3135	0.2407	-0.09885	0.5024
q29	0.3741	0.2772	0.1826	0.285	-0.2053	-0.02251	0.2028	0.2361	-0.2936	-0.3293	-0.3017	0.2421	-0.002118	0.4064
q30	0.3923	0.3301	0.1611	0.3458	-0.1668	0.03344	0.1798	0.167	-0.2031	-0.2902	-0.2994	0.2554	-0.03155	0.2878
q31	0.2192	0.1493	0.1292	0.1209	-0.2087	-0.04469	0.1681	0.1753	-0.2547	-0.2789	-0.3566	0.131	0.01492	0.2935

	q16	q17	q18	q19	q20	q21	q22	q23	q25	q26	q27	q28	q29	q30	q31
q1	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q2	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q3	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q4	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q5	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

q6	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q7	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q8	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q9	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q11	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q12	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q13	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q14	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q15	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q16	1	------	------	------	------	------	------	------	------	------	------	------	------	------	------
q17	-0.4111	1	------	------	------	------	------	------	------	------	------	------	------	------	------
q18	0.4704	-0.4015	1	------	------	------	------	------	------	------	------	------	------	------	------
q19	-0.312	0.498	-0.2751	1	------	------	------	------	------	------	------	------	------	------	------

q20	-0.2843	0.2864	-0.2803	0.4997	1	------	------	------	------	------	------	------	------	------	------
q21	0.1237	-0.06831	0.1174	-0.1356	-0.1196	1	------	------	------	------	------	------	------	------	------
q22	0.1636	-0.1134	0.2094	-0.101	-0.08013	0.458	1	------	------	------	------	------	------	------	------
q23	-0.08286	0.0715	-0.158	-0.01791	0.1139	-0.11	-0.1339	1	------	------	------	------	------	------	------
q25	-0.00131	0.1403	-0.06944	-0.03574	0.01875	0.1355	0.03486	0.02065	1	------	------	------	------	------	------
q26	0.5116	-0.3618	0.5812	-0.2818	-0.3936	0.1549	0.1282	-0.1447	-0.05143	1	------	------	------	------	------
q27	-0.1109	0.143	-0.3777	0.08426	0.1291	-0.01359	0.0767	0.1876	0.05141	-0.3463	1	------	------	------	------
q28	0.5002	-0.3812	0.511	-0.42	-0.4065	0.2366	0.1388	0.04357	-0.06199	0.5772	-0.2258	1	------	------	------
q29	0.404	-0.3356	0.3833	-0.3747	-0.5286	0.1832	0.1233	0.08423	-0.07876	0.5241	-0.2267	0.701	1	------	------
q30	0.3438	-0.3356	0.3549	-0.2563	-0.44	0.1958	0.1579	-0.01138	-0.01599	0.4941	-0.2284	0.5276	0.7126	1	------
q31	0.2893	-0.2611	0.2521	-0.4425	-0.5785	0.1907	0.02731	0.0457	0.01618	0.3302	-0.2461	0.5262	0.6276	0.398	

Chapter 7:

Appendix 7.1. Questionnaire QA.2 (ideal) designed to be filled in by prospective cat-adopters prior to the selection or rehoming of a cat.

UNIVERSITY OF LINCOLN

Cat questionnaire

UNIVERSITY OF LINCOLN

This questionnaire is part of an on-going research project conducted by the University of Lincoln and sponsored by International Cat Care and the Centre Of Applied Pet Ethology (COAPE). Its aims are to improve the quality of life of rescue and re-homed cats. We are interested in gathering information about the ideal behavioural characteristics of cats, as well as finding out how the behaviour of cats may or may not change when they are rehomed.

We would be very grateful if you could spare the time now to fill in this questionnaire (it doesn't take long!) Your participation in this study is greatly appreciated!!

This questionnaire is confidential and will not be read by members of cattery staff, only by researchers at the University of Lincoln. Any answers given here will not influence your cat adoption process. If you would like to get in touch about this research for any reason, please email **Lauren Finka** at **lfinka@lincoln.ac.uk.**

Please sign and print your name to indicate that you give your consent to participate in this study and for your contact details only to be shared between a researcher at the University and the rehoming centre, for the purpose of this study. If you would prefer not to participate, please leave this form blank.

I give my consent to participate in this study:

Full Name:

……………………………………………………………………………………………

Signature:

……………………………………………………………………………………………

Your IDEAL cat:

Instructions:

Based on the IDEAL characteristics you would like a cat to have, please indicate how much you agree or disagree with the following statements in relation to your IDEAL cat.

- Please answer this questionnaire as honestly as possible. There are no right or wrong answers - we are purely interested in your individual preferences and opinions.

- Please answer all questions by circling the response that is most appropriate. If you are unsure of an answer please circle the 'Unsure' option.
  Example question:

I want a cat I can groom everyday

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

Please answer the following questions:

I'd like a cat I am able to work with (e.g one that may be fearful or has other behavioural issues but that I can help to 'bring round'):

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that won't try to avoid me when I try to encourage interaction (i.e – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc):

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that won't try to avoid me when I go to stroke it or tickle its chin/cheeks:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that is comfortable being picked up:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

When I try to initiate contact or interaction with the cat, I don't want it to be unresponsive towards me (i.e not purr or rub up against me in return):

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

It's important the cat isn't timid:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that enjoys long stroking sessions with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that is vocal and 'talks' to me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that will come and ask me for attention and initiate contact with me (e.g. a cat that will come and sit on my knee, or rub up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles):

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don't want a cat that behaves aggressively (i.e. growl, hiss, bite, swipe with claws) towards me when I stroke it:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don't want a cat that behaves aggressively (i.e. grow, hiss, bite, swipe with claws) towards me when I have to perform routine health procedures (such as grooming/ carrying out health checks, or when administering medication, etc.):

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that is keen to explore its environment and is interested in new things:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that that is quick to settle and to adapt to change:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that is playful:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don't want a cat that gets carried away during play, which then leads to me getting bitten or swiped at:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I’d like a cat that would prefer to be left alone, rather than be with people:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don’t want a cat that <u>likes</u> being stroked:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don’t want a cat that is very <u>tolerant</u> of being handled:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don't want to worry whether the cat might behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws) when I stroke it:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don’t want a cat that seems angry:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that if it could choose, it would prefer to have a bowl of food rather than interact with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that is keen to interact with me whether I have food/treats or not:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that behaves the same with strangers as it does with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

I'd like a cat that behaves the same with all (human) members of the household:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure Or, not applicable

It's not important to me that the cat is friendly:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I don't want a cat that seems fearful:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like a cat that seems happy to live with me:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

I'd like to adopt the right cat for me so that I would never have to rehome it:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Or, Unsure

P.T.O

Cat behaviour follow-up

The cats currently within the rehoming centre are involved in a long-term study. Your support of this work is greatly appreciated but not a condition of adoption. If you decide to adopt a cat and have filled in this questionnaire, the University of Lincoln will contact you a week, 3 months and 6 months after you have adopted your cat, and will ask you to fill out a short 'follow-up' questionnaire each time about their behaviour (this shouldn't take more than 10 minutes to fill in). You are however free to opt out of the study at any time if you wish.

The 'follow-up' information you provide to the University will be treated as strictly confidential and will not be shared with the rehoming centre or any other parties.

Please indicate a preferred means of contact and provide contact details so that we can send the future 'follow-up' questionnaires to you when necessary.

☐ I would like to fill in future follow-up questionnaires **online** (this is very straightforward)

My email address is:………

☐ I would like to receive the questionnaires **via Post** and return in pre-paid addressed envelopes

My preferred address is:

…………………………………………………………………………………………………

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Finished!

Thank-you☺ !!

If you would like to be entered in to a draw to win a free membership to International Cat Care, please tick this box: ☐

Please place your questionnaire within the envelope provided and hand back to a member of reception staff

Appendix 7.2. Questionnaire QA.2, adapted from QA.1 (owner) and designed to be filled in by prospective adopters prior to reserving or adopting a cat. Questionnaire items are mapped against specific behavioural traits, their hypothesised relationship with underpinning emotional processes (marked with an ‘X’) and whether they involve social elements (s) (i.e. in relation to the human in an interactive capacity), or physical elements (p) (i.e. the general external environment, or to humans in a non-interactive, non-social capacity).

Questionnaire A.2	**Sociability (social) SEEKING**	**Boldness (social/physical) SEEKING with the absence of FEAR**	**Gregariousness (Sociability + boldness)**	**Fearfulness (Social/physical) FEAR**	**Propensity to aggress (Social/physical) RAGE**	**Frustration reactivity (Social/physical) RAGE**	**Resource motivated-ness (Physical) SEEKING-**	**Behavioural stability**	**Owner-preference/perception**
1.a I’d like a cat I am able to work with (e.g. one that may be fearful or has other behavioural issues but that I can help to ‘bring round’)				**X(s,p)**	**X(s,p)**	**X(s,p)**			**X**
1. I’d like a cat that won’t try to avoid me when I try to encourage interaction (i.e. – when I call its name in a friendly voice, when I make kissing noises, or crouch down and offer it my fingers, etc.)				**X(s)**		**X(s)**			
2. I’d like a cat that won’t try to avoid me when I go to stroke it or tickle its chin/cheeks				**X(s)**		**X(s)**			
3. I’d like a cat that is comfortable being picked up	**X(s)**	**X(s)**	**X(s)**						
4. When I try to initiate contact or interaction with the cat, I don’t want it to be unresponsive towards me (i.e. not purr or rub up against me in return)				**X(s)**					
5. It’s important the cat isn’t timid				**X(s,p)**					
6. I’d like a cat that enjoys long stroking sessions with me		**X(s)**				**X(s)**			
7. I’d like a cat that is vocal and ‘talks’ to me	**X(s)**					**X(s)**			

8. I'd like a cat that will come and ask me for attention and initiate contact with me (e.g. a cat that will come and sit on my knee, or rub up against me and around me, in order to receive fusses/ strokes/ chin/cheek tickles)	**X(s)**	**X(s)**	**X(s)**						
9. I don't want a cat that behaves aggressively (i.e. growl, hiss, bite, swipe with claws) towards me when I stroke it				**X(s)**	**X(s)**	**X(s)**			
10. I don't want a cat that behaves aggressively (i.e. grow, hiss, bite, swipe with claws) towards me when I have to perform routine health procedures (such as grooming/ carrying out health checks, or when administering medication, etc.)				**X(s)**	**X(s)**	**X(s)**			
11. I'd like a cat that is keen to explore its environment and is interested in new things		**X(p)**					**X(p)**		
12. I'd like a cat that that is quick to settle and to adapt to change		**X(p)**					**X(p)**		
13. I'd like a cat that is playful	**X(s)**						**X(p)**		
14. I don't want a cat that gets carried away during play, which then leads to me getting bitten or swiped at					**X(p)**	**X(p)**			
15. I'd like a cat that would prefer to be left alone, rather than be with people	**X(s)**								
16. I don't want a cat that <u>likes</u> being stroked	**X(s)**	**X(s)**	**X(s)**						
17. I don't want a cat that is very <u>tolerant</u> of being handled	**X(s)**	**X(s)**	**X(s)**						
18. I don't want to worry whether the cat might behave aggressively towards me (i.e. growl, hiss, bite, swipe with claws) when I stroke it:				**X(s)**	**X(s)**	**X(s)**			
19. I don't want a cat that seems angry						**X(s,p)**			

20. I'd like a cat that if it could choose, it would prefer to have a bowl of food rather than interact with me							**X(p)**		
21. I'd like a cat that is keen to interact with me whether I have food/treats or not							**X(p)**		
22. I'd like a cat that behaves the same with strangers as it does with me				**X(s)**				**X**	
23. I'd like a cat that behaves the same with all (human) members of the household				**X(s)**				**X**	
24. It's not important to me that the cat is friendly	**X(s)**	**X(s)**	**X(s)**						
25. I don't want a cat that seems fearful				**X(s,p)**					
26. I'd like a cat that seems happy to live with me									**X**
27. I'd like to adopt the right cat for me so that I would never have to rehome it									**X**

Publications:

Finka, L., Ellis, S. L. H., Wilkinson, A., & Mills, D. (2014). The development of an emotional ethogram for Felis silvestris focused on FEAR and RAGE. *Journal of Veterinary Behavior: Clinical Applications and Research*, *6*(9), e5.

Finka, L. R., Ellis, S. L., & Stavisky, J. (2014). A critically appraised topic (CAT) to compare the effects of single and multi-cat housing on physiological and behavioural measures of stress in domestic cats in confined environments. *BMC veterinary research, 10*(1), 73.

Sparkes, A. H., Bessant, C., Cope, K., Ellis, S. L., Finka, L., Halls, V., ... & Yeates, J. (2013). ISFM guidelines on population management and welfare of unowned domestic cats (Felis catus). *Journal of feline medicine and surgery*,*15*(9), 811-817.

Conference Talks:

2012

International Cat Care (ICC) Annual feline conference 2012: 'Challenges of predicting human-sociability in the cat'

University of Lincoln Animal Behaviour Clinic seminar 2012: 'Low stress handling in cats'

2013

International Cat Care (ICC) Cat Group expert panel 2013: 'The importance of critically appraising scientific literature'

University of Lincoln Animal Behaviour Clinic seminar 2013: 'Assessing Human-Sociability in cats'

2014

International Cat Care (ICC) Annual feline conference 2014 : ‘Assessing human sociability in cats - determining what's reliable and what's practical in the rehoming environment’

Association of Dogs and Cat Homes annual conference (ADCH) 2014: ‘Assessing cats for rehoming – what do we need to know?’

Association of Pet Behaviour Councillors (APBC) feline conference 2014: ‘Assessing human sociability in cats - determining what's reliable and what's practical in the rehoming environment’

Canine and Feline Science Forum (CSF/FSF) 2014 : ‘The development of an emotional ethogram for *Felis silvestris,* focusing on FEAR and RAGE’

University of Lincoln Animal Behaviour Clinic seminar 2014: ‘What factors influence expectations and owner satisfaction?’

2015

British Veterinary Behaviour Association (BVBA) study day 2015: ‘Two’s company, three’s a crowd? Multi-cat lifestyles in 21st Britain for feral, rescue and domestic cats’

Association of Dogs and Cat Homes annual conference (ADCH) 2015: ‘Recognising & Responding to Behaviour in Rehoming Centre Cats to Achieve Successful Adoption’

Poster presentations:

Association for the Study of Animal Behaviour (ASAB) 2012 (Easter conference): ‘The effects of human familiarity and interaction style upon the behavioural responses of cats’

International Veterinary Behaviour Meeting (IVBM) 2013: ‘Assessing human-sociability in cats: Developing reliable behavioural tests’